Engineering News

VOLUME 73 JUNE 24, 1915 NUMBER 25

Messhouse Management at the Arrowrock Dam

By Ray R. Clawson*

In the construction of the Arrowrock Dam near Boise, Idaho, it has been necessary to operate messes of sufficient capacity to accommodate 800 to 900 men. This operation, extending over a period of about four years, has given a good opportunity to make studies of possible interest to contractors and engineers.

In these days of unusual agitation on account of the "high cost of living" the management of messhouses on large construction work where numbers of healthy laboring men are fed at an established price per meal becomes a very interesting problem. The generally established price on work of this nature in the West is 25c. per meal. For this price it is necessary that the men be fed a substantial ration, including meat and other food, and it is usually expected by the management that a small margin of profit will be made.

The satisfactory operation of the messhouse is one of the controlling elements in keeping an efficient force on construction work. Those in charge of the work soon learn that it is economy to serve good meals, even at a loss, to the mess.

Dining-Room Service

Good service is as important as good food. No matter how much time the men may have for eating, they are generally in a hurry. Meals should therefore always be served on time, and particular effort should be made to give prompt service.

At Arrowrock small tables accommodating eight persons are provided, as this number may be served from one set of dish-ups. These small tables have been found to be a decided improvement over the long tables commonly used in construction camps. Separate dining rooms are provided for the different classes of employees—one room

Fig. 1. Kitchen Force Preparing Vegetables in Arrowrock Dam Messhouse

*Principal Clerk, United States Reclamation Service, Arrowrock, Idaho.

for foremen, mechanics, carpenters, etc.; one for American laborers and one for foreign laborers. The employees are better satisfied if they are classified in this manner at table, as they are better able to select their associates. At Arrowrock very little trouble has been given by a desire on the part of any one of the above-mentioned classes to encroach upon the others, after they have been once classified.

Service is made "family style"; that is, all food is on the table at the time the meal is called. With this method one waiter can attend to five tables of eight persons each in an efficient manner. When the force is large enough to justify it, a head waiter is employed to supervise the setting up of tables and the work of preparing the cold part of the meal; and it is his duty to see that all dishes are thoroughly cleaned before they are placed

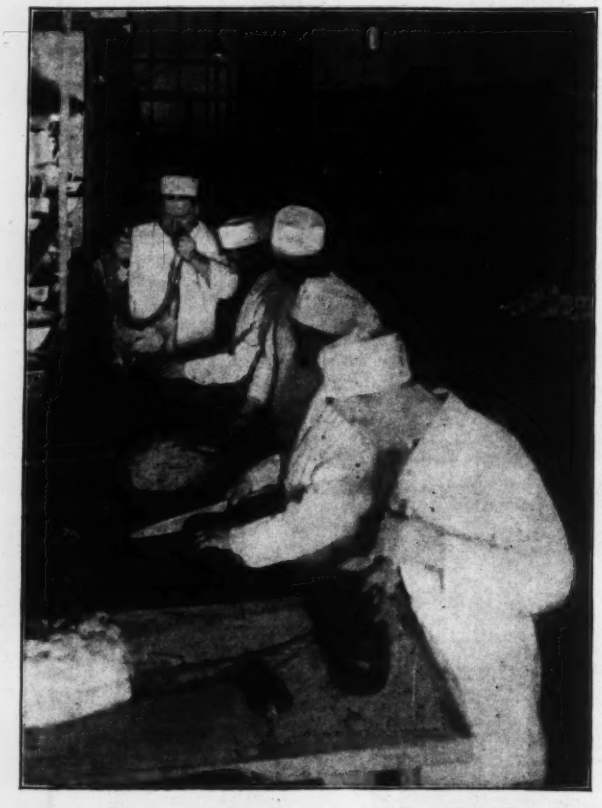


FIG. 2. PREPARING MEAT IN THE MESSHOUSE KITCHEN AT THE ARROWROCK DAM

on the tables, as this is one of the things which has to be carefully watched over in camps.

KITCHEN EQUIPMENT

Although the messhouse may be considered a small feature of a construction job, there is probably no place where labor-saving equipment can be used to greater advantage. Every possible piece of equipment should be power-driven.

At Arrowrock, where electrical power is available, the following pieces of motor-driven equipment have been used with very satisfactory results: Vegetable peeler, dish-washing machine, coffee grinder, combination potato and vegetable masher, and meat grinder.

The vegetable peeler and dish-washing machine are the two greatest labor savers, and the character of service obtained with them is much better than it would be possible to obtain by hand.

The center range, composed of six sections, has a total cooking surface of 72 sq.ft. There is a steam-table, which has proved to be a very economical piece of equipment for carrying cooked foods from one meal to the next without loss or deterioration. There is also a steam cooker for steaming vegetables, boiling eggs, making puddings, etc., where there is danger of burning if cooked on the range.

On account of the great number of dishes required in serving as large a number as we are handling at Arrowrock, we have found it advisable to use enamelware dishes, as the dish-washing machine is particularly efficient in cleaning this ware. In smaller messes, however, I have known of heavy hotel chinaware dishes being used with success.

CHOICE AND UTILIZATION OF FOODSTUFFS

The economy in the preparation and serving of food is not so much in reducing what is actually eaten by the men as it is in keeping the waste down to the minimum. The most important factor in the economical use of foodstuffs is therefore the utilization of all food cooked and the preparation of food in such a manner that the portion left over may be modified in some form and used again at a subsequent meal. It must always be borne in mind that the class of men being fed on work of this nature have no interest in the economical use of food. The food must therefore be prepared in such a way that any unusual waste may be detected.

Meat is by far the most expensive item of diet, and therefore more attention must be given to its use than to that of any other item. At Arrowrock, where physical conditions make it necessary to keep meat for a considerable length of time, it has been necessary to provide refrigeration facilities. Our refrigeration plant is what is commonly called the "brine system." We have one cold-storage room with sufficient capacity for storing about 26,000 lb. of meat and another smaller room for storing eggs, butter, etc. Provision is also made for the freezing of forty 50-lb. cakes of ice at one time, and we are able to produce ice in about 20 hr. continuous running of the plant. This is used around the work in warm weather, and is sold to the families in the camp, of which there are as many as 150 or 200 during most of the year.

Purchase of meat is made by the carcass. Pork sides and trimmings are made into pork sausage and stuffed into casings, after a sufficient quantity has been salted to provide all of the salt bacon required. Hogs' heads, together with other trimmings, are made into headcheese and stuffed into casings and served cold. After a little experience with the requirements a definite system can be worked out so that every particle of usable meat can be used as wholesome food.

From actual experience and test at Arrowrock it has been found much more economical to remove all bones from the meat before it is cooked. These bones are then used for soup stock, and in this manner every particle of meat is cooked from them and utilized. If the bones are cooked and served with the meat, a considerable portion of meat is always left on the bones by the men when eating, and this is an absolute loss. The serving of excess fat meat is also avoided, because if only the actual edible meat is served it will lessen the tendency on the part of

the men to be wasteful in the use of meat. Excess fat is absolute waste if served, but can be trimmed off before cooking and rendered into marketable lard or tallow.

A lard-rendering kettle has been provided, and all fats are carefully cared for and rendered. Sufficient lard has been manufactured for use at the mess and for sale to the families who desire it, and occasional shipments of pure lard are made to wholesale merchants in the vicinity, where it brings the same price as the packing-house product. All tallow and refuse fats are rendered, and practically all of this product has been transferred to the machine shop, where it has been manufactured into "cable dressing," which has been used on the work with good results. Credit is given to the messhouse operations for the market price of this tallow, and still a considerable saving has been made in the cost of cable dressing after allowing this price. Occasional shipments of excess tallow have been made to the nearest soap-making establishments. It has been found to be poor economy to make this tallow and grease into "home-made soap," as we have been able to obtain 5c. per lb. for it at the soap works, and common laundry soap can be bought for less and gives much better results. In this manner the general tendency to use home-made soap extravagantly under the assumption that it is cheap is also done away with.

Ordering Seasonable Articles

It is necessary that constant attention be given to ordering to avoid the purchase of articles which are out of season or on which the market price for one reason or another may be prohibitively high. Fresh berries, fruits and green vegetables may be served plentifully in the height of the season, but should not be served until the full crop is on the market and the price is low. If the market is carefully watched, practically all perishable produce, even though it may be regarded as a luxury, may be economically served at some time of the year. For example, it is generally thought that fruits such as bananas and oranges cannot be served in a mess for 25c. per meal; but at certain times of the year, in the height of season, when the local market may be in a slump on account of an oversupply, these may be served prepared in a salad at a saving over the ordinary canned fruits. Watermelons and cantaloups can be used to the exclusion of all fruits after the full supply is on the market and the price is reduced. Constant effort should be made to find something in the market on which the price is reasonable and which may reduce the consumption of meat. Practically anything which may be served which will reduce the consumption of meat will prove to be an economy. Moreover, the variety thus afforded is worth while, even if no special saving is effected thereby.

The views in Figs. 1 and 2 show the messhouse employees at work preparing the food to be set before the men.

Costkeeping

A sufficient charge is made against messhouse operations each month for rental to absorb the cost of messhouse construction during the time of construction. A monthly charge is also made to cover the depreciation of equipment.

It is very necessary that a careful record of cost be kept and reports prepared each month to show the results accomplished. Classification of cost should be made into the principal items of cost, so that the items may be compared from month to month. The following cost accounts have been used in connection with the messhouse operations at Arrowrock:

Labor, cooks and helpers.
Labor, miscellaneous.
Subsistence.
Supplies.
Utensils.
Rental.
Fuel.
Lights.
Depreciation of equipment.
General and overhead expense.

By comparison of the cost report with the preceding reports it is possible to detect where the cost is running high, and an effort can then be made to reduce this item. After the mess has been operated for a sufficient length of time, certain standards of cost will be established, and effort can then be made by watching these cost reports to maintain these standards. Different local conditions, such as transportation facilities, etc., make it impracticable to compare cost data thus assembled covering operations in different localities, but these data are very valuable for comparison of cost of operation of messes in the same locality where the conditions are similar.

From data kept under this classification it is possible to prepare at the end of the month cost reports in the following form:

DEPARTMENT OF THE INTERIOR
United States Reclamation Service
Boise Project, Idaho

Field Report of Messhouse Operations at Main Mess, Arrowrock, during the month of September, 1914.

DEBITS		Account Nos. 730 to 739	CREDITS		
Inventory:			Collections:		
Subsistence	533.46		Cash	135.40	
Supplies	26.22		Coupons	96.00	
Utensils	1500.00	2,059.68	Meal tickets		231.40
Received during month:			Deducted on timebooks:		
Subsistence	8134.89		Arrowrock	10,479.25	
Supplies	344.71		B. & A. Ry.	598.50	11,077.75
Utensils	35.52	8,515.12			
Labor:					
Cooks and helpers	1559.10		Deductions on disability claims	12.75	12.75
Miscellaneous	21.50	1,580.60			
Miscellaneous expenses:			Miscellaneous credits:		
Rental	160.00		Meals served to hospital patients	173.80	173.80
Fuel	247.50				
Lights	15.00				
Depreciation on equipment	50.00	472.50			
			Inventory:		
			Subsistence	788.49	
			Supplies	26.15	
			Utensils	1,350.00	2,164.64
Profit		1,032.44			
Total		13,660.34	Total		13,660.34
Total cost for month		10,463.26	Total number men, days		16,249
Total number of meals furnished		48,748	Unit cost per man, day		.644
Unit cost per meal		.215	Labor cost per man, day		.097
No. lb. of meat used		21,471	Supplies cost per man, day		.021
No. lb. meat used per man, day		1.3	Misc. exp. cost per man, day		.041
			Gen. exp. cost per man, day		.000
			Subsistence cost per man, day		.485

Some of the things which have been mentioned in this article may seem to be trivial details, but it must be remembered that the management of this operation is a mass of details and failure to give attention to the smallest feature may change the operation from a paying to a losing proposition.

The Arrowrock Dam is being constructed in the Idaho District of the United States Reclamation Service, of which F. E. Weymouth is Supervising Engineer. Charles H. Paul, Construction Engineer, has general charge of all features in connection with the construction of the dam. James Munn, Superintendent of Construction, has direct charge of construction work. The writer has direct charge of messhouse operations and incidental features.

Intercolonial Railway Pier 2 at Halifax Harbor, Nova Scotia

By A. F. Dyer*

SYNOPSIS—A reinforced-concrete pier on long unsupported concrete piles in an ocean harbor subjected to severe ice conditions. Special pile construction and driving.

The Department of Railways and Canals of Canada is just completing in Halifax Harbor the construction of new Pier 2, which is the first of a series of shipping piers in a project to enlarge the terminals of the Intercolonial Railway. The particular scheme of which this pier is a part was initiated in 1910 and comprises the construction and reconstruction of four large piers, replacing all of the other piers owned by the railway at Halifax. The general layout is shown in Fig. 1. In 1912 another project, entirely separate from the one noted, was started by the department. This comprises a landing quay, piers and a breakwater at the southerly part of Halifax Harbor, with a new double-track connection from the present tracks in the north part of the city. The first scheme is in charge of John Kennedy, Consulting Engineer to the Montreal Harbor Commissioners; the second, of F. W. Cowie, Chief Engineer of the Montreal Harbor Commissioners. The present article describes the construction of the first unit, Pier 2, of the first-named scheme.

In designing the new piers the two considerations of economy of construction and permanency of the structure determined the type to be used, which is a reinforced-concrete floor supported on reinforced-concrete piles. This type of construction was well suited to the local conditions of the site, where the depth of rock bottom varied from 42 to 68 ft. below low-water level of spring tides, which compelled the building of a substructure below the pier floor of from 61 to 87 ft.

Borings taken over the site of the new pier indicated that a layer of hard clay or hardpan covered the rock to a depth which varied from 2 to 12 ft. Above the hardpan there was found a layer of soft mud that had a depth of nearly 30 ft. at the shore end, but ran out to about 5 ft. at the outer end of the proposed pier.

The elevation of the pier deck was fixed at 19 ft. 2 in. above extreme low-water level of spring tides, which is 3 ft. 6 in. above the top of rail of the tracks in the yard. Owing to the small height of the structure above low water compared with the depth of the foundations below low water, a system of diagonal transverse bracing would not have greatly increased the stability of the pier and its ability to withstand the shock of a large vessel striking it on one of its sides; therefore, recourse was had to the use of reinforced-concrete brace piles driven at an angle of one in three to the vertical and having their heads consolidated with the transverse girders of the pier floor. It is believed that this is the first instance of such a system of bracing being used for a reinforced-concrete pile pier. Further stiffening of the structure was obtained by forming a bank of dredged material under the outer end of the pier, where the depth of water was greatest and the thickness of the material overlying the rock was least.

*Resident Engineer, Canadian Government Railways, Halifax, N. S

Concrete in Sea Water

The question of the durability of reinforced-concrete piles immersed in sea water in a climate such as prevails during the winter months in Halifax had now to be dealt with. The large ratio between the surface exposed and the bulk of the concrete in this type of construction is one of its weak points, and special measures had to be taken to prevent any deteriorating action of the water on the concrete.

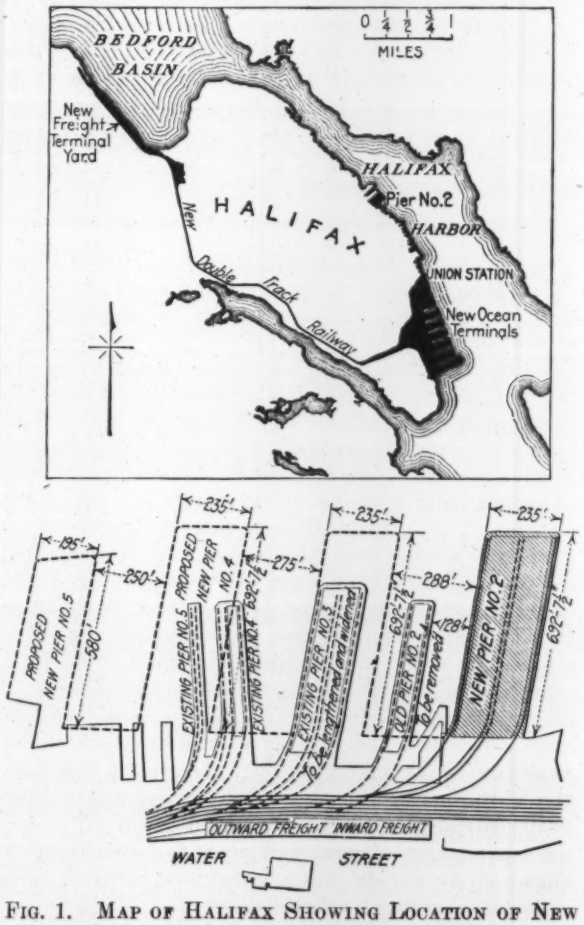


Fig. 1. Map of Halifax Showing Location of New Pier Projects and (below) Enlarged Layout of Northern Terminal

The principal causes of deterioration of concrete immersed in sea water act between the levels of low and high water and are: (1) The chemical action between the magnesium sulphate contained in sea water and the alumina in the portland cement, which forms a sulphoaluminate of lime within the concrete, thus disintegrating and weakening the structure; (2) the intermittent wetting and drying of the concrete with the rise and fall of the

tide, which causes an increase in its porosity, ultimately allowing the water to reach the reinforcing steel, which, on rusting, swells and bursts off portions of the concrete; (3) the freezing at low tide of the water absorbed by the outer surface of the concrete at high tide, with consequent scaling of the surface and exposure of fresh surfaces; (4) the abrading action of floating ice on the concrete surfaces. Causes 3 and 4 are the most active along the coasts of Nova Scotia, where the temperature frequently falls to zero, during at least three months in the year.

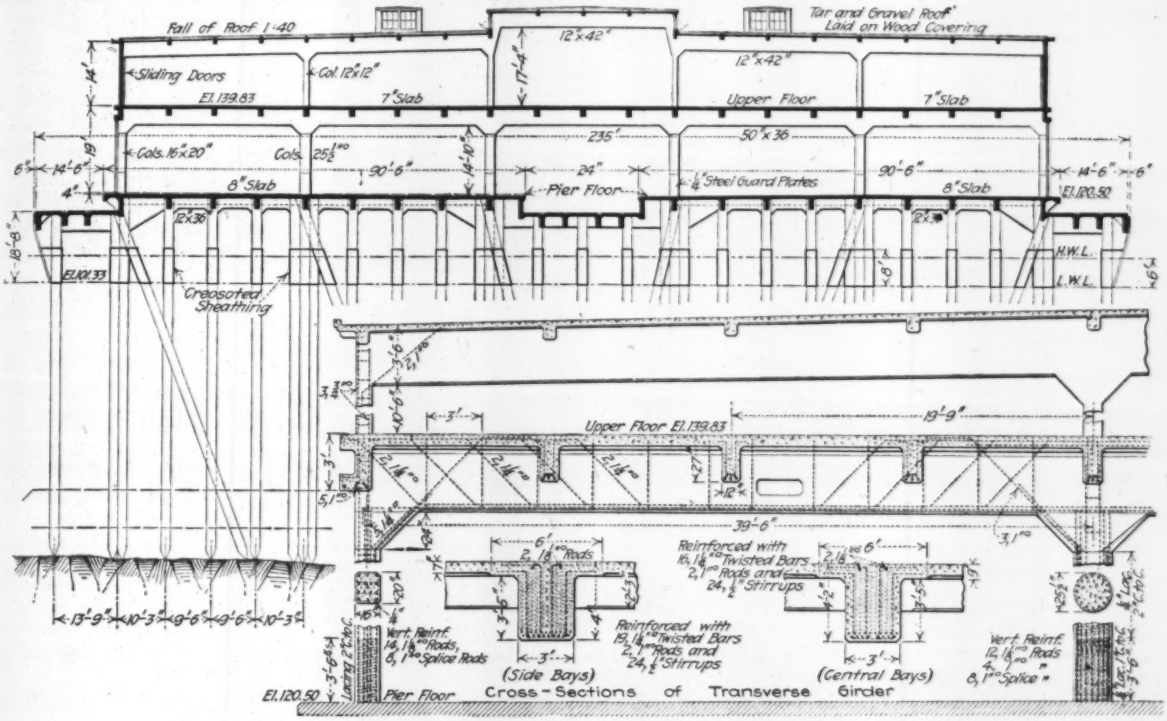


FIG. 2. DETAILS OF PIER 2, INTERCOLONIAL RY. TERMINAL, HALIFAX HARBOR

The measures taken to prevent, as far as possible, the above-mentioned actions on the piles were: (1) The portland cement used for the making of all concrete below high-water level did not contain more than 6.3% of alumina; (2) all concrete below high-water level was mixed in the proportions of 1 part cement, 1½ parts sand and 3 parts crushed quartzite gravel, with the object of obtaining a rich and as dense and nonporous a concrete as possible; (3) all concrete surfaces from low-water level to about 2 ft. above high water were sheathed with two layers of 2-in. creosoted pine planking, bedded on cement mortar. The inner surfaces of the planks were coated with pitch to prevent any deteriorating action taking place between the creosote in the wood and the concrete of the piles. This sheathing keeps the concrete surfaces moist, prevents all frost action and protects the concrete from abrasion by ice as well as the wearing action of the wash of the water.

GENERAL DESIGN

The pier is 235 ft. wide and 693 ft. long and carries a two-story freight shed 200 ft. wide and extending from

FIGS. 3 AND 4. HEAD HOUSE AND SIDE ELEVATION OF PIER 2

the bulkhead line to within 15 ft. of the outer end of the pier. This shed allows room to run a railway track along each edge of the pier. Two additional railway tracks run the whole length of the shed down the center of the pier, dividing the lower floor into two separate freight floors each 88 ft. in width. The columns supporting the shed are spaced 39 ft. 6 in. transversely and 18 ft. longitudinally, the long transverse span being decided upon in order to facilitate the handling of gangways.

The loads for which the pier and shed floors are designed are: Pier deck, 1000 lb. per sq.ft. live-load; track girders, 4500 lb. per running foot of each rail live-load; upper floor of shed, 500 lb. per sq.ft. live-load; and roof, 110 lb. per sq.ft. total load.

Reinforced-Concrete Piles

The longitudinal spacing of the shed columns determined the distance between bents of piles, and it was decided to use piles capable of supporting a load of at least 100 tons, including their own weight in water. This compelled the use of piles 24 in. square in section and required 33 vertical and 6 sloping piles in each bent. Two vertical and 1 sloping piles are located beneath each side column of the shed, 3 vertical and 1 sloping piles beneath each interior column, and the remainder of the vertical piles are spaced out between the column groups at approximately 10ft. centers. They range in length from 57 to 77 ft. and were driven with the special pile-driver described hereinafter.

The amount of reinforcement in the piles varied in accordance with their length as cast and was fixed by the amount required for their safe handling when being placed in position for driving. All piles under 60 ft. in length are reinforced with eight 1-in. round rods longitudinally; 1⅛-in. rods were used for piles over 60 ft. and under 70 ft. in length, and 1¼-in. rods for those over 70 ft. in length. One-quarter-inch lacing rods securely tied to the longitudinal reinforcement at 12-in. centers were used. All longitudinal reinforcing rods were continuous from end to end of each pile, no laps being allowed. The points of the piles are tapered for a length of 1 ft. 9 in. and finished 3 in. square, being reinforced with four additional 1⅛-in. rods and ¼-in. spiral hooping at 2-in. pitch. No metal shoes were used. Some additional stirrups were placed near the head of the piles to prevent excessive breakage while driving, and the longitudinal rods were allowed to project 3 ft. beyond the concrete to save the labor of cutting away the concrete in order to secure the necessary bond of the pile reinforcement with the concrete of the pier deck. A staple made from a 1¼-in. square steel bar was also cast into the head of the pile for use in handling it in the leads of the piledriver. In order to minimize the bending moments during handling it was specified that all piles were to be lifted in such way that they were suspended at points one-fifth of their length from each end while in a horizontal position. By the observance of this rule the cracking of the piles while being conveyed from the molding yard to their ultimate position ready for driving was entirely eliminated.

The piles to be driven as brace piles were reinforced in a similar manner to the vertical ones, but were cast with a camber, so that when built into the pier and under an axial load of 80 tons, the stresses on the cross-section of the concrete due to this load and the bending moment of its own weight would be uniform. The amount of camber required was determined by equating the moment due to the axial load into the unknown camber to the moment due to the weight of the pile in water.

The camber equals the bending moment due to weight of pile after being driven in water at angle divided by 160,000 lb.

This formula gives the camber required for a pile 45 ft. long as 2 in. and 5½ in. for one 75 ft. long. Brace piles were placed so that their heads could be built into

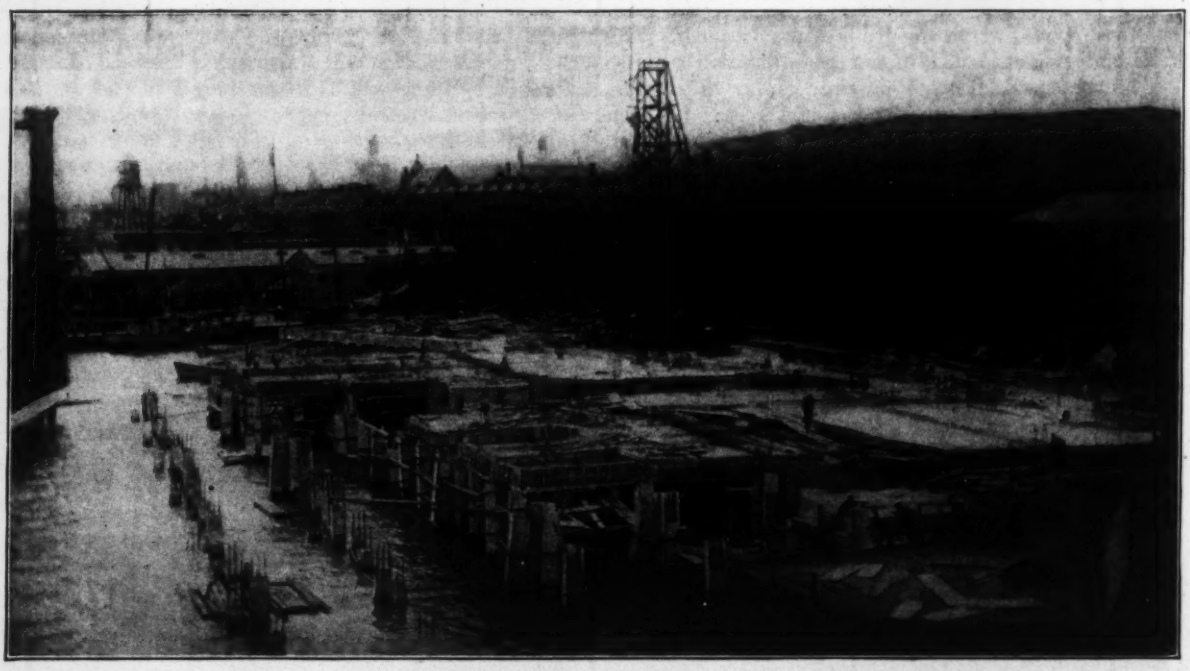


Fig. 5. Pier 2 in Early Stages of Construction
(Note batter piles and also wooden casing for piles above water)

FIG. 6. BUILDING THE SHED ON PIER 2, INTERCOLONIAL RY., HALIFAX

the deck beams immediately under a shed column, so that all danger of a brace pile breaking through the pier deck was prevented. The number of concrete piles used in the work is 1801, 238 of which were driven at an angle as bracing piles.

REINFORCED-CONCRETE DETAILS

The pier deck is built entirely of reinforced concrete carried on reinforced-concrete girders 36 in. deep, which run transversely across the pier along the pile bents and on girders of the same depth running longitudinally at an average of 9 ft. 10½-in. centers. The 18x9 ft. 10½-in. rectangle thus formed is divided again by a transverse floor-beam 24 in. deep. The slab is 8 in. thick, reinforced in both directions with ½-in. round rods at 7-in. centers, every alternate rod being bent up over the supporting beam. The design is detailed in Fig. 2.

All beams and girders are designed as T-beams, sufficient web reinforcement being used to take care of the excessive shearing stresses, the top ends of the U-stirrups being bent horizontally and carried into the slab as far as the table of the T extends, in order that the shearing stresses occurring between the web and table be properly cared for.

Owing to the side and central railway tracks being carried at a level 3 ft. 6 in. below that of the pier deck proper, transverse concrete gussets were built in at the four breaks in the floor level so that the rigidity of the floor system would be maintained from one side of the pier to the other and the whole floor would act as a monolith in resisting the shocks of large vessels.

A concrete beam 51 in. deep is carried along each edge of the pier, and to the outside of this is secured a rubbing fender of pitch pine with a vertical face of 20 in. At the outer corners of the pier the depth of the fender beam was increased to about 11 ft., the corners being cut diagonally across, leaving a flat concrete surface 16 ft. wide by 11 ft. deep, strongly braced at the back by gussets from the pier floor. Numerous holes were left in this concrete face for attaching thereto fenders made of birch or willow saplings bound together into bundles.*

The interior columns supporting the upper floor of the shed are circular in cross-section, 25½ in. diameter, reinforced with 1⅛-in. vertical rods and ¼-in. hooping at 1-in. pitch. The side columns are rectangular in section, 16x20 in., reinforced with vertical rods with ¼-in. lacing at 6-in. centers.

The upper floor-beam system consists of transverse girders supported on the six columns of each bent and longitudinal beams at 9 ft. 10½-in. centers carrying a concrete slab 7 in. in thickness. The transverse girders have a span of 39 ft. 6 in. c. to c. of columns. In order to reduce the height of the upper floor above the pier deck to a minimum and at the same time to have adequate headroom for the lower story, the depth of the girders was made 50 in. and the thickness of the floor-slab was increased to 9 in. for a strip of 18 in. along each side of the girder, to provide sufficient compression area. The heavy shearing stresses were taken care of by bending the ends of eight of the horizontal rods in each beam diagonally up at intervals as required and also by the addition of U stirrups. Knee-brace brackets are provided at the heads of all columns to insure lateral stiffness. The width of the girders was made 36 in. to provide plenty of concrete for the proper bedding in of the large amount of reinforcing steel.

The roof consists of tar and gravel roofing laid on boarding and carried on a light reinforced-concrete slab.

*Described in "Engineering News," June 3, 1915, p. 1083.

The roof-beam system consists of 12x42-in. transverse girders carried on 12x12-in. concrete posts and 8x12-in. longitudinal beams with spans the same as the upper floor. The center bay of the roof is raised 5 ft. for the total length of the building, thus forming a monitor and providing good light for the upper story.

Steel sliding doors inclose each side of the lower story except for a length of 72 ft. at the shore end given over

FIG. 7. THE CONCRETE PILE YARD AT HALIFAX

to shipping and railway offices. On the upper floor a 17-ft. opening closed with two steel sliding doors is provided at 36-ft. centers. All sliding doors for both floors are provided with windows glazed with ribbed wire glass.

The two end walls of the shed are of reinforced concrete. The entrance for the two central railway tracks through the west end wall, 33 ft. wide by 18 ft. high, is provided with a rolling steel-slat door, as are also the 18-ft. wide roadway entrances. All window frames are of steel glazed with wire glass.

There are no expansion joints in either the pier deck or the upper floor, but as the upper story is to be temporarily used for an immigration examination building and will be heated during the winter months, it was thought advisable to leave expansion joints in the roof to relieve the bending stresses which would occur in the columns toward the ends and sides of the building.

Transverse joints are made by simply leaving a ½-in. space midway between two bents of columns, the longitudinal beams thus cut being designed as cantilevers. Where it was necessary to have an expansion joint to guard against transverse expansion, it was made by having the north end of the monitor girders rest on steel plates and rollers. (Fig. 9.)

PILE MAKING

A level area of sandy beach about seven miles by water from the site of the new pier was leased and graded for a pile-making yard. To the back of this area were large deposits of gravel and coarse sand, which on examination proved to be mostly composed of quartzite. Cubes and briquettes of mortar made from this material and cement easily passed the limits of strength required by the specifications, which were based on those of the Canadian Society of Civil Engineers.

The molding yard measured 800x600-ft. (Fig. 7.) A gravel-excavating, crushing and concrete-mixing tower was erected at the east end of the yard, mounted on wheels which ran on tracks across the whole width of the yard. Parallel tracks were laid across the west end of the yard, on which an anchor tower, similarly mounted on wheels, was placed and a cableway stretched between the two for the conveying of the concrete to the pile molds.

On top of the main tower, 80 ft. above track level, was placed a winding winch operating a dragline excavating bucket. This bucket emptied its contents of sand and gravel into a hopper over a grizzly, all stones not passing through being conveyed to a jaw crusher. The material then passed ¼-in. and 1-in. screens to separate the sand from the stone, any stones not passing through the 1-in. screen being elevated to a second crusher.

Chutes from the stone and sand bins led the materials to the mixer platform, where they were measured before passing into the one-yard batch mixer which discharged each batch into a bottom-dumping bucket that traveled along the aërial cableway to the pile molds.

Once the concreting of a pair of piles began, no stop was allowed before they were completed, so that all joints were eliminated. The first pile was concreted on May 21, 1912, and all were completed by Dec. 17 of the same year. The maximum amount of concrete poured by this plant in a day of 10 hr. was 168 cu.yd.

A timber pier 1000 ft. long by 22 ft. wide except for 85 ft. at its outer end, where its width is increased to 38 ft., carrying one railway track and a 30-ton loading

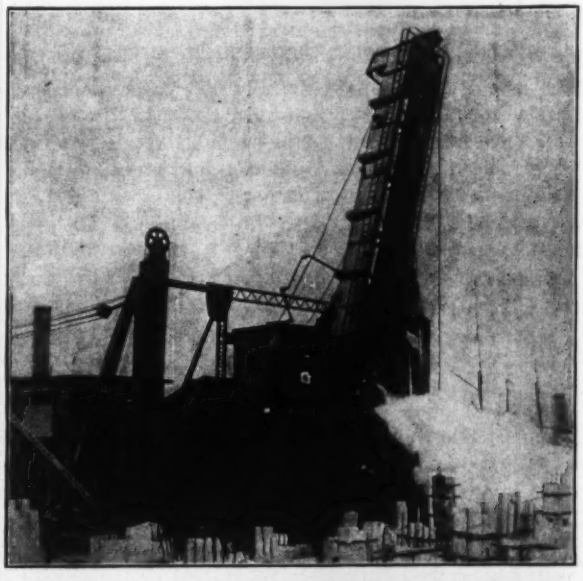


FIG. 8. THE PILEDRIVER DRIVING A BATTER PILE

derrick at its outer end, was built at the west end of the pier, extending westward into the harbor. This pier was also equipped with stone- and sand-storage bins.

Owing to the weight of the concrete piles, the smallest of which weighed 12 tons and the largest 46,000 lb., the conveying of them to the site of the work presented certain difficulties. The railway track from the loading

pier was continued along the north side of the yard. Counterweighted cars with projecting ends were used for bringing the pile to the pier track. These cars were furnished with a heavy screw-jack on their overhanging ends, by which the pile was raised off the mold bottom and laid between the two rails of the longitudinal track. It was there raised up under two cars which straddle the pile and pushed out to the pier head, where the derrick lifted it onto a scow for conveyance to the new pier. The scows used were capable of taking nine piles on each trip.

Piledriving

The difficulty of driving such long and so many battered piles required the adoption of a very heavy and somewhat complicated piledriver which was capable of being easily moved in any direction and shifted in any angle in the vertical plane. This machine, manufactured by the Bucyrus Co., was fully described in Engineering News, May 28, 1914, p. 1198. (Fig. 8.)

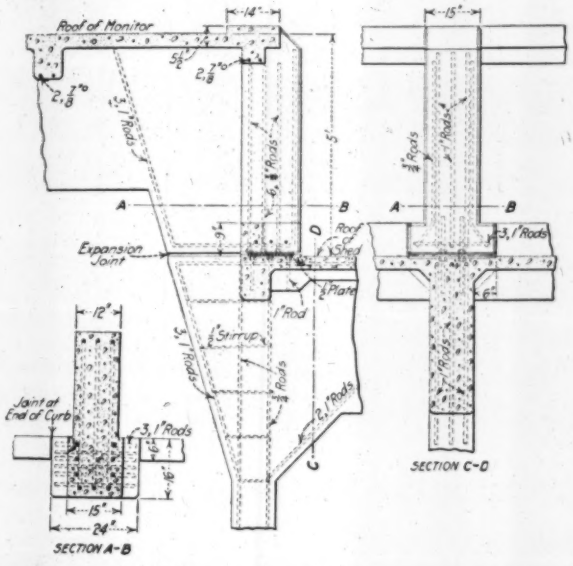


Fig. 9. Detail of Expansion Joint at Monitor

The method followed in placing and driving a pile was as follows: The piledriver scow was first placed in position by means of cross-ranges and anchored by lowering her spuds. Straps were placed around the pile to be driven as it lay on the deck of the scow on which it had been brought up from the yard and it was lifted horizontally by one of the forward derricks and swung round in front of the driver so that the head of the pile came in front of the pile leads. The swinging was accomplished by manipulating the forward spuds of the piledriver scow. The pile fall, having been made fast to the staple projecting out of the head of the pile, was hoisted up and at the same time the derrick fall was lowered and the pile gradually raised into a vertical position, the straps being taken off as the strain came off them. The pile leads were then moved as required for the exact centering of the pile. On the pile being lowered it penetrated the overlying soft mud with its own weight. This mud was found to have sufficient stiffness to hold the pile vertically when its depth was about equal to one-third of the length of the pile. As a general rule, however, the piles had to be stayed while the hammer was being adjusted on their heads.

Three separate cushions were used between the head of the pile and the ram of the hammer. On top of the pile was first placed 3 in. of spruce plank. On this rested a cast-steel follower about 4 ft. in height, designed to protect the projecting reinforcing rods and staple. This follower consisted of a hollow steel cylinder with top and bottom flanges. The bottom flange was flat and provided with holes through which the projecting rods passed and by means of which the pile was firmly held while being driven. The top flange had a rectangular depression on its upper side, in which was placed a hardwood block about 15 in. thick, bound round with steel bands. This block received the direct strokes of the hammer and had to be frequently renewed. At times one of these blocks would break up after the driving of only two piles, while others would stand the hammering of twenty, the breakage of the steel band usually being the cause of failure; although at times the heart of the block would become charred owing to the heat generated by the force of the blows.

The amount of hammering which the piles required to drive them to refusal varied a great deal. In some places where the depth of the hardpan was small the pile would come to a stop after 200 to 300 blows, while in other places they would require nearly 1800 blows to drive them to rock. The rate of penetration through the hardpan was small, the last foot or so in many cases being penetrated at not more than $^1/_{30}$ in. per stroke.

The following are records of the driving of three piles which show the great variation met with:

	1	2	3
Number of strokes of hammer.....	1010	505	240
Total amount of penetration, in....	107	0.37	23.2
Average penetration per blow, in...	0.1	0.073	0.1
Average penetration per blow during last foot, in.....	0.033	0.036	0.059

Very little damage was done to the piles by the hammering. Only two had their heads badly smashed. These were among the first few piles driven, and the cause of the shattering was the continuation of the hammering after the pile had reached rock. A few blows of the hammer after penetration had stopped did no damage. In a few cases pieces of concrete would be knocked off the top edges of the pile head, usually due to a tendency of the pile to drive to one side or the other, thus making the hammer bear unevenly. To determine what was taking place at the point of the pile, several were pulled up after having been driven to refusal. Out of nine thus pulled and examined only one showed any damage, and in that case a sharp point of rock had been encountered which had entered the concrete point of the pile and spalled a small piece off the corner.

When no machine troubles were met with an average of 10 piles could be set and driven in 10 hr. In some weeks, however, the average would slightly exceed 12 per day, and the best day's work was 18.

In order to test the bearing power of the piles after driving, load tests were made with a floating load of 180,000 lb. on certain piles. The load, which consisted of two scows of 90,000 lb. weight each, was attached to the ends of a steel girder resting on the head of the pile and made fast at high tide, the pile and load being securely braced to prevent swaying of the former when under load. On the tide falling the whole load was carried by the pile.

Tests were made on piles which had been driven to different degrees of penetration with the following results:

Pile going $\frac{1}{5}$ in. per blow, settlement under load $\frac{1}{15}$ in.
Pile going $\frac{1}{2}$ in. per blow, settlement under load $\frac{1}{20}$ in.
Pile driven to refusal, settlement under load nil.

The problem of building forms of the necessary strength and stiffness on the short length of pile projecting above the water was not an easy one, but was successfully solved by the contractors. Horizontal wales of 4x8-in. sticks were bolted on each side of the piles as soon after driving as possible, and on these were erected the vertical forms for the building up of the pile to deck level. The bottoms of the beam forms were carried on joists supported by the pile-extension forms and braced by diagonal shores from the pile walings. Slight settlement of the forms took place on the pouring of the deck concrete, but in no case did any failure occur. It was found that by filling the pile extension forms at least 24 hr. ahead of the pouring of the deck, the settlement was reduced considerably.

By the middle of December, 1913, the piles had been driven and the pier floor completed to within 115 ft. of the outer end, at which place the work was suspended until the following spring, and the portion of the pier built was equipped with temporary wooden freight sheds and used throughout the winter by freight steamers. During this time the ability of the pier to withstand lateral blows from large vessels was demonstrated on more than one occasion. In every case the plates of the steamers were the sufferers from the impact. Work was resumed in May, 1914, and the whole of the concrete work completed by December, 1914.

Personnel

The contract for the construction of the pier and shed has been carried out by the Nova Scotia Construction Co. under the management of Hamilton Lindsay, assisted by J. Shepherd Lee. John Kennedy is Consulting Engineer for the Dominion Government for the work and was assisted in the design by the writer, who has acted as Resident Engineer on the construction, assisted by R. A. Lockerby. The cost of the work complete will be about $1,125,000.

Volcanic Activity of Mt. Lassen

By Thomas H. Means*

One hundred eruptions of Mt. Lassen, California, have been observed since May 30, 1914, when the first one took place. The writer recently made a trip to the volcano, and his observations were of considerable interest to himself, and will probably be to other engineers.

After a long period of comparative quiescence, during the night of May 20, 1915, a violent eruption occurred, and a tremendous flood of mud and water ran down the northeastern slope of the peak into the headwaters of Hat Creek. In the afternoon of May 22 a second and more violent eruption occurred, the steam cloud rising to a height of 5½ mi. above the top of the cone (as calculated from transit observations made by Joseph L. Reading, an engineer in Redding). This second big eruption was accompanied by another mud flood.

The northeastern slope of Mt. Lassen is very steep, being nearly 45 deg. in places. Two ridges or shoulders, one running to the east and one to the north, form a cirque or cove which is more than a mile wide. Prior to May, 1914, this cirque was filled with a glacier of unknown depth. Deep snow and ice remained here at the end of a hot dry summer. Nearly all other exposures of the peak were denuded of snow each year. This glacier varied in

*Symmes & Means, Agricultural Engineers, 58 Sutter St., San Francisco, Calif.

Four Views of 99th Eruption of Mt. Lassen, May 30, 1915

(The three upper views from left to right show cloud—at 5:15 p.m., at 5:20 p.m., at 5:25 p.m. In the lower view observe the boulder in the foreground, which was transported from the distant volcano by the mud stream)

EROSION AND DÉBRIS FROM FLOODS OF MAY 20 AND 22, 1915

length from about 10,000 to 7500 ft. Since the eruption of May 20, 1915, this side of the mountain has been greatly changed. The glacier is gone, the mountainside is bare, and in the center of the cirque, where the snow was deepest, a line of steam holes extends from the crater's top down 7000 ft.

Mud and water sliding down this mountainside gained sufficient momentum to splash and run up the opposite mountainside to elevations of 200 ft. or more above the valley bottoms. The flood then divided, part going down Upper Hat Creek and part down Lost Creek, the main tributary of Hat Creek.

This flood carried with it trees, brush, rocks, boulders and mud, and swept a pathway from 600 to 1000 ft. wide, leaving a desolation of mud and boulders, with here and there logs and brush, as shown in the views. In the upper valleys the waters rose from 10 to 30 ft. Lower down the stream the crest flattened out and the water was absorbed by the valleys and the porous cove, and at Cassels (35 mi. distant) the rise did not exceed 6 in. The character of the destruction in the upper parts of the valley indicates that the flood was plastic, as though mud and ice were abundant.

It is very difficult to estimate the volume of the flood at maximum flow, for we have no measure of the velocity. At several points the area of the cross-section of the stream was estimated by pacing, and it was found to average 6000 sq.ft. The velocity was great enough to roll rocks 10 ft. in diameter. The average velocity of the flood for the first 10 mi. was roughly estimated at 15 to 20 ft. per sec. In the upper Meadows the writer believes the water must have flowed at a rate of 30 ft. per sec. Even with these rough figures it is seen that the flood must have been between 90,000 and 180,000 sec.-ft. in Lost Creek alone. No estimate was made for Upper Hat Creek.

No evidence of molten rock has yet been found around Lassen. That the rocks are getting hot no one can deny. We found a boulder 10 ft. high by 60 ft. in circumference which had been carried by the water 2 mi. from the crater. Our visit took place 8 days after the second flood and 10 days after the first, and yet this rock was too hot to touch and hot enough to ignite a match.

There is no evidence to show that rocks have been dropped on any point a mile away from the main crater. A search of the hillsides for 1½ mi. around revealed nothing so large as a pea. Dust, or volcanic ash, has been found several miles away, and the ground within 2 mi. of the crater shows the results of several dust showers.

On May 30, 1915, during a visit to Upper Hat Creek, a very beautiful eruption was observed from a distance of about 5 mi. Photographs of this eruption, taken by the writer, are reproduced herewith. The height of the steam cloud was estimated to be 7000 ft. above the crater.

Mt. Lassen eruptions have increased in intensity, but to date they have been associated with the wet season and the period of melting snow. Whether the water which makes the steam comes from some distant source, such as the ocean or Big Meadows Reservoir, is a question yet unanswered.

Exposition of American Chemical Industries—The first American exposition of chemical industries will be held at Grand Central Palace, New York City, during the week beginning Sept. 20, 1915. It is to be managed by C. F. Roth and A. Nagelvoort, assisted by an advisory committee of nine eminent chemical engineers. It is expected to include coal, wood and petroleum products, metals, minerals, water and sewage purification, air and gas processes, glass and ceramics, oils, varnishes, plastics, rubber, leather, glue, etc. Working exhibits will be shown. Inquiries should be directed to the National Exposition of Chemical Industries, 46th St. and Lexington Ave., New York City.

Relative Reliability of Long-Time Rainfall Observations

By F. H. Millard*

In dealing with rainfall there is always the feeling that one more year's observations might bring a maximum or minimum rainfall entirely out of relation to those observed in previous years. It would be very satisfactory if one could observe the rainfall for a year and then state with assurance that this is an average year or a year which bears a certain definite relation to the average of all years.

Recently there have appeared two tabulations—one covering the rainfall in Milwaukee for a period of 63 years and the other covering rainfall for 100 years at New Bedford, Mass. It is of considerable interest to take these rainfall records and to combine consecutive years into groups of varying lengths and to note the maximum and minimum average rainfall per year obtained by these combinations of consecutive years.

TABLE I. VARIATION IN YEARLY RAINFALL IN INCHES DURING PERIODS OF VARIOUS LENGTHS

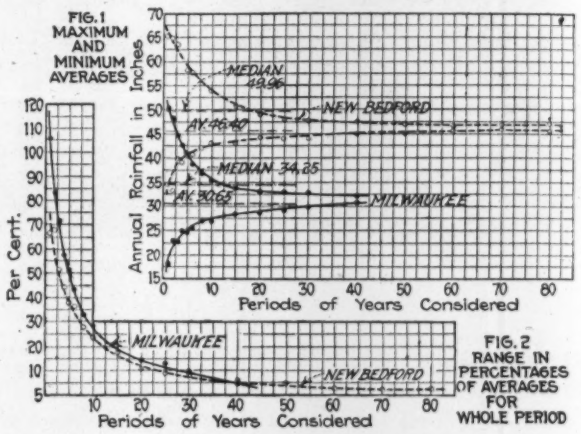
Number of Years Observed	63-Year Record at Milwaukee, Maximum	Minimum	Variation	100-Year Record at New Bedford, Maximum	Minimum	Variation
1	50.4	18.1	32.3	65.41	34.51	30.90
2	48.3	22.9	25.4	65.04	33.58	31.46
3	44.6	22.7	21.9	63.75	40.06	23.69
4	42.6	24.9	17.7	60.14	39.40	20.74
5	40.3	24.6	15.7	58.64	41.13	17.51
6	38.7	25.5	13.2	57.99	41.06	16.93
8	36.9	26.9	10.0	54.99	42.08	12.91
10	35.5	26.8	8.7	54.26	43.23	11.03
15	33.9	28.4	5.5	51.00	43.24	7.76
20	33.2	28.7	4.5	49.24	44.52	4.72
25	33.1	29.1	4.0	48.35	44.36	3.99
30	32.7	29.8	2.9	48.07	44.37	3.70
40	32.2	30.7	1.5	47.86	45.16	2.70
50	....	....	....	47.20	45.17	2.03
60	....	....	....	46.92	45.93	0.99
70	....	....	....	47.12	46.07	1.05
80	....	....	....	47.28	45.97	1.31

Table I shows the results of these groupings and Fig. 1 gives the same information in graphic form. It is interesting to note the fact that the variations above the average are considerably larger than the variations below the average, and that if one is to observe for a short period only, the variation above the average is likely to be appreciably larger than the variation below the average.

Table II shows the percentage which the average rainfall per year, determined from the maximum and minimum groups of different lengths, is of the average rainfall per year for all observations. It will be noted that in one case the maximum single year exceeded the average by over 60%, while the minimum year was less than the average by 40%. In the other case the figures show a variation of 40% above the average for the maximum and 26% below the average for the minimum. Taking 10-year periods, the maximum is only 16% greater than the average, while the minimum is 13% less in one case, the maximum being 17% greater and the minimum 7% less in the other case.

Fig. 2 shows graphically the range from the maximum to the minimum in per cent. of the averages for both series of figures and for groupings of different lengths. These curves are remarkably similar.

Table II shows also the percentage variation of each length of observation in terms of the percentage variation of the five-year observations. The five-year period was arbitrarily taken as a unit, and from this table it appears that in the matter of accuracy the increase of the period of observation from one year to five years does more than the inclusion of an additional 35 years in the one case, and in the other, it appears that the inclusion of the first four additional years contributes to the accuracy of the averages observed to about the same extent that the inclusion of an additional 20 years would.



Figs. 1 and 2. Maximum and Minimum Average Yearly Rainfalls for Various Periods at Milwaukee and New Bedford

(Based on a 63-yr. record at Milwaukee and a 100-yr. record at New Bedford)

TABLE II. PERCENTAGES WHICH AVERAGE RAINFALL FOR VARIOUS SUB-PERIODS ARE OF AVERAGE RAINFALL FOR WHOLE PERIOD

	63-Year Record at Milwaukee Average per Year, 30.65 in.							100-Year Record at New Bedford Average per Year, 46.40 in.						
No. of Years Observed	Max., in.	% of Aver.	Min., in.	% of Aver.	Range, in.	% of Aver.	% of 5-Yr. Range, 15.7 in.	Max., in.	% of Aver.	Min., in.	% of Aver.	Range, in.	% of Aver.	% of 5-Yr. Range, 17.51 in.
1	50.4	164.4	18.1	59.0	32.3	105.4	205.7	65.41	141.0	34.51	74.4	30.90	66.6	176.5
2	48.3	157.6	22.9	74.7	25.4	82.9	161.8	65.04	140.2	33.58	72.4	31.46	67.8	179.7
3	44.6	145.5	22.7	74.0	21.9	71.5	139.5	63.75	137.4	40.06	86.3	23.69	51.1	135.3
4	42.6	139.0	24.9	81.2	17.7	57.7	112.7	60.14	130.0	39.40	84.9	20.74	44.7	118.4
5	40.3	131.5	24.6	80.3	15.7	51.2	.....	58.64	126.4	41.13	88.6	17.51	37.7	.....
6	38.7	126.3	25.5	83.2	13.2	43.1	84.1	57.99	124.8	41.06	88.4	16.93	36.4	96.7
8	36.9	120.4	26.9	87.8	10.0	32.6	63.7	54.99	118.4	42.08	90.6	12.91	27.8	73.7
10	35.5	115.8	26.8	87.4	8.7	28.4	55.4	54.26	116.9	43.23	93.2	11.03	23.8	63.0
15	33.9	110.6	28.4	92.7	5.5	17.9	35.0	51.00	110.0	43.24	93.2	7.76	16.7	44.3
20	33.2	108.3	28.7	93.6	4.5	14.7	28.7	49.24	106.1	44.52	95.9	4.72	10.2	27.0
25	33.1	108.0	29.1	94.9	4.0	13.1	25.5	48.35	104.2	44.36	95.6	3.99	8.6	22.8
30	32.7	106.7	29.8	97.2	2.9	9.5	18.5	48.07	103.6	44.37	95.6	3.70	8.0	21.1
40	32.2	105.1	30.7	100.2	1.5	4.9	9.6	47.86	103.1	45.16	97.3	2.70	5.8	15.4
50	....	.....	....	.....	.....	.....	.....	47.20	101.7	45.17	97.3	2.03	4.4	11.6
60	....	.....	....	.....	.....	.....	.....	46.92	101.1	45.93	99.0	0.99	2.1	5.7
70	....	.....	....	.....	.....	.....	.....	47.12	101.6	46.07	99.3	1.05	2.3	6.0
80	....	.....	....	.....	.....	.....	.....	47.28	101.9	45.97	99.1	1.31	2.8	7.5

No attempt has been made to study these figures with the aid of higher mathematics, and the curves are shown here as illustrative of the increasing accuracy of rainfall observations when averages are based on records covering increased periods of time. More such long-time records should be made available in order that the curves here shown representing rainfall on the Eastern seaboard and in the Great Lakes district may be compared with rainfall on the Pacific Coast or in the Plains states.

*145 Iota Court, Madison, Wis.

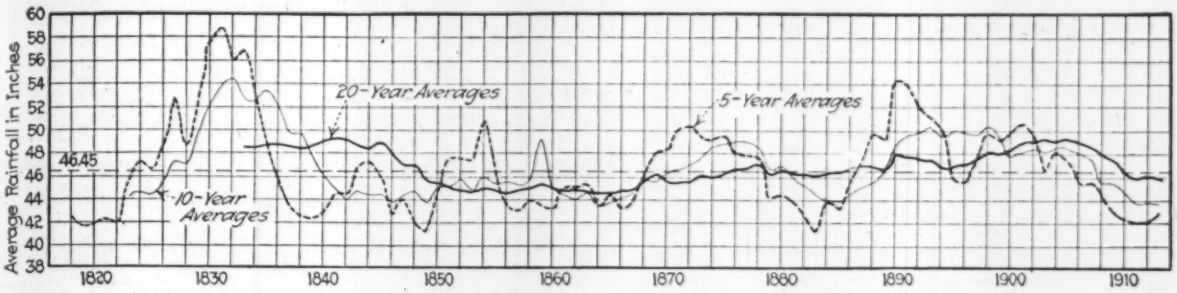
Average Rainfall in the Light of the New Bedford Record

By N. M. Stineman*

An article in Engineering News of Nov. 19, 1914. by X. H. Goodnough gives a continuous record of rainfall at New Bedford, Mass., from 1814 to 1913 inclusive. A thorough discussion of the record is given in the article; but further investigation throws light upon the question as to what reliance may be placed upon records of a much shorter duration. Would rainfall observations continued for 5, 10 or 20 years be of any value?

Recently I had occasion to analyze the New Bedford records, in order to determine, if possible, the probable value of a record which is continuous for only 20 years. The accompanying diagram gives the results. Five-year, 10-year and 20-year averages are plotted to the same scale, the ordinate over any given year representing the average for the period ending with that year. For example, at the ordinate 1840 may be read the average rainfall for the 5-year period from 1836 to 1840, the 10-year period from 1831 to 1840 and the 20-year period from 1821 to 1840.

Assuming for the time being that the New Bedford record is an indication of what might be expected elsewhere, the curves show conclusively that a 5-year record is too short to give dependable results. The averages vary from 41.13 in. to 58.64 in. Expressed in different terms, these figures vary from 11.4% below to 26.2% above the 100-year average of 46.45 in. The 10-year curve is more regular than the 5-year curve; but the ordinates vary from 6.9% below to 16.8% above the 100-year average. On the other hand, the 20-year averages vary only from 44.48 in. to 49.24 in., or from 4.2% below the 100-year average to 6% above. Hence during the entire century it would not have been possible to select any 20 successive years in which the average rainfall would have deviated by more than 6% from the 100-year average.



Comparison of Rainfall Averages for 5-, 10- and 20-Year Periods, New Bedford, Mass.

This should be accurate enough for all practical purposes, although an examination of the 20-year curve shows further that only in a few cases does a variation of as much as 6% occur. About 77% of the 20-year averages fall within 4% of the average for the century, which is close enough for most purposes.

It would be interesting to know whether other long rainfall records would show similar results, and whether these conclusions could properly be applied to the flow of rivers.

COMPARISON OF RAINFALL AVERAGES, NEW BEDFORD, MASS.

Year at End of Period	5-Year Averages	10-Year Averages	20-Year Averages	Year at End of Period	5-Year Averages	10-Year Averages	20-Year Averages
1814				1864	43.11	43.24	44.59
15				65	44.37	43.74	44.48
16				66	43.14	44.06	44.77
17				67	43.90	44.44	44.83
18	42.42			68	46.14	45.67	45.61
19	41.73			69	47.94	45.52	46.29
1820	41.84			1870	48.17	46.27	45.51
21	42.14			71	50.03	46.58	45.41
22	41.83			72	50.14	47.02	45.49
23	45.66	44.04		73	49.21	47.68	46.10
24	47.19	44.46		74	49.09	48.52	45.88
25	46.55	44.20		75	49.32	48.75	46.24
26	48.37	45.26		76	47.84	48.93	46.50
27	52.60	47.22		77	47.72	48.93	46.09
28	48.43	47.04		78	47.49	48.35	47.01
29	52.04	49.62		79	44.08	46.59	46.06
1830	57.36	51.95		1880	44.43	46.88	46.57
31	58.64	53.51		81	43.81	45.83	46.20
32	55.92	54.26		82	42.68	45.20	46.11
33	56.64	52.53	48.28	83	41.27	44.38	46.03
34	52.58	52.31	48.39	84	43.81	43.94	46.23
35	49.09	53.22	48.71	85	43.16	43.79	46.27
36	45.42	52.03	48.64	86	45.31	44.56	46.75
37	43.37	49.64	48.43	87	47.39	45.03	46.98
38	42.50	49.57	48.31	88	49.70	45.48	46.92
39	42.35	47.47	48.54	89	49.24	46.52	46.56
1840	42.83	45.96	48.96	1890	54.22	48.69	47.78
41	44.38	44.90	49.20	91	53.81	49.56	47.69
42	44.38	43.88	49.07	92	52.03	49.71	47.45
43	46.86	44.68	48.61	93	51.07	50.38	47.38
44	46.13	44.24	48.28	94	49.70	49.47	46.71
45	45.82	44.33	48.77	95	45.69	49.95	46.87
46	42.61	43.50	47.76	96	45.67	49.74	47.15
47	43.98	44.18	46.91	97	47.22	49.62	47.33
48	41.99	44.42	47.00	98	49.68	50.37	47.93
49	41.13	43.63	45.55	99	49.07	49.39	47.96
1850	44.05	44.94	45.45	1900	49.74	47.72	48.20
51	47.47	45.04	44.97	01	50.57	48.12	48.84
52	47.52	45.75	44.81	02	49.54	48.38	49.04
53	47.26	44.63	44.65	03	46.52	48.10	49.24
54	50.74	45.93	45.09	04	47.96	48.52	49.00
55	46.41	45.23	44.78	05	47.23	48.48	49.22
56	43.50	45.49	44.49	06	45.47	48.02	48.88
57	42.93	45.22	44.70	07	45.49	47.52	48.57
58	43.85	45.55	44.99	08	44.37	45.44	47.91
59	43.37	47.06	45.34	09	42.88	45.42	47.40
1860	43.12	44.76	44.85	1910	42.22	44.72	46.22
61	44.99	44.25	44.64	11	42.03	43.75	45.94
62	44.99	43.96	44.85	12	42.08	43.79	46.08
63	45.20	44.52	44.58	13	42.82	43.60	45.85

*4923 Winthrop Ave., Chicago, Ill.

Pumping Plant for Dry Dock No. 1, Balboa Terminal, Balboa, C. Z., will be furnished by Henry R. Worthington, New York, under a contract recently let. The plant comprises four main pumps, two drainage pumps and one bilge pump. The four main units are identical in all parts, each consisting of a 54-in. vertical-shaft, single suction, single-impeller, volute centrifugal pump, with a minimum capacity of 11,000 cu.ft. of sea water per minute, when pumping against static heads ranging from 0 to 48 ft., and when operating at 250 r.p.m. Each unit is direct-connected to a 1000-hp. constant-speed alternating-current vertical-shaft motor of the squirrel-cage induction type, three-phase, 25-cycle current at 2200 volts. The average overall efficiency of each unit pumping against the total heads encountered must be not less than 64.5%. The two drainage pumps are of the same type as the main units, each consisting of a 20-in., vertical-shaft, volute centrifugal pump with a minimum capacity of 1200 cu.ft. of sea water per minute, against the range of heads encountered, when operating at a speed of 750 r.p.m. The bilge pump is of the vertical self-contained centrifugal type, having 4-in. suction and 3-in. discharge, with a capacity of 25 cu.ft. of sea water per minute when pumping against any stage of the tide. The overall efficiency is specified at not less than 32%. The contractor will also furnish the floors, platforms, gangways, ladders, stairs and handrails necessary for safe and convenient access to all parts of the plant equipment. The time for delivery of all the material is specified at 210 days. The Balboa dry dock is one of the largest in the world, having a length of 1110 ft., an entrance width of 110 ft. and a depth over the sills of 41.5 ft. at high water.

Concrete Bridges with Stone and Brick Facing

By C. E. Drayer*

The use of facing on concrete bridges is displayed in interesting contrast by two recently built arch bridges in Fort Wayne, Ind. In both cases the esthetic value of the facing quite evidently justifies its use. To what extent the facing affects repair and maintenance charges will have to be learned from slow experience.

Brick Facing: Tennessee Ave. Bridge

Tennessee Ave. crosses the St. Joseph River by two reinforced-concrete arch spans of 105 ft. The view shown in Fig. 1 brings out the successful selection of form and the good appearance of the bridge in adaptation to the surroundings. The bridge has an ornamental facing of dark brick and white stone. The balustrade is wholly built of brick and stone, the panels being of brick, while the coping and posts are of stone. In the facing of the arch itself stone is used only for the quoins and for picking out the panels.

The main surface of the arch is formed of wire-cut brick of deep-red color, with matt surface, and is laid in Flemish bond. There is enough variation of color in the brick itself to make the surface as a whole quite picturesquely variegated (see Fig. 2). The stone trim is No. 1 oölitic Bedford sandstone. The pieces used in the balustrade are of very substantial character, the coping rail being in one piece between posts or 12 ft. 8½ in. long. The intermediate posts are solid single pieces extending through the thickness of the balustrade, and the pier caps are single pieces 3 ft. 5½ in. by 9 ft. 4 in.

The bridge was designed by A. W. Grosvenor, of Fort Wayne, and built under his supervision by the Lafayette Engineering Co., Lafayette, Ind., contractor. Above the arch barrel no forms were used. The concrete was placed inside the brick facing, the latter being carried up sufficiently in advance to permit of doing this concreting in 2-ft. layers.

The cost of the bridge was a little over $39,000, including the pile foundation.

*1801 East 93d St., Cleveland, Ohio.

Stone Facing: Coombs St. Bridge

Fig. 3 shows the stone-faced bridge over the Maumee River on Coombs St., in the suburb of Lakeside. Here

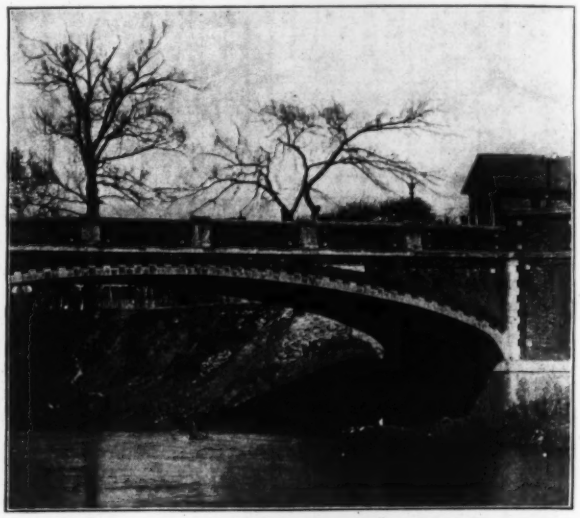


Fig. 2. Detail View, Tennessee Ave. Bridge

the facing used is sandstone. The esthetic effect depends largely on the emphasis of the arch barrel by the quarry-faced ring stones of the facing, although the effect is somewhat reduced by the detail of the railing. The cost of this bridge was about $65,000.

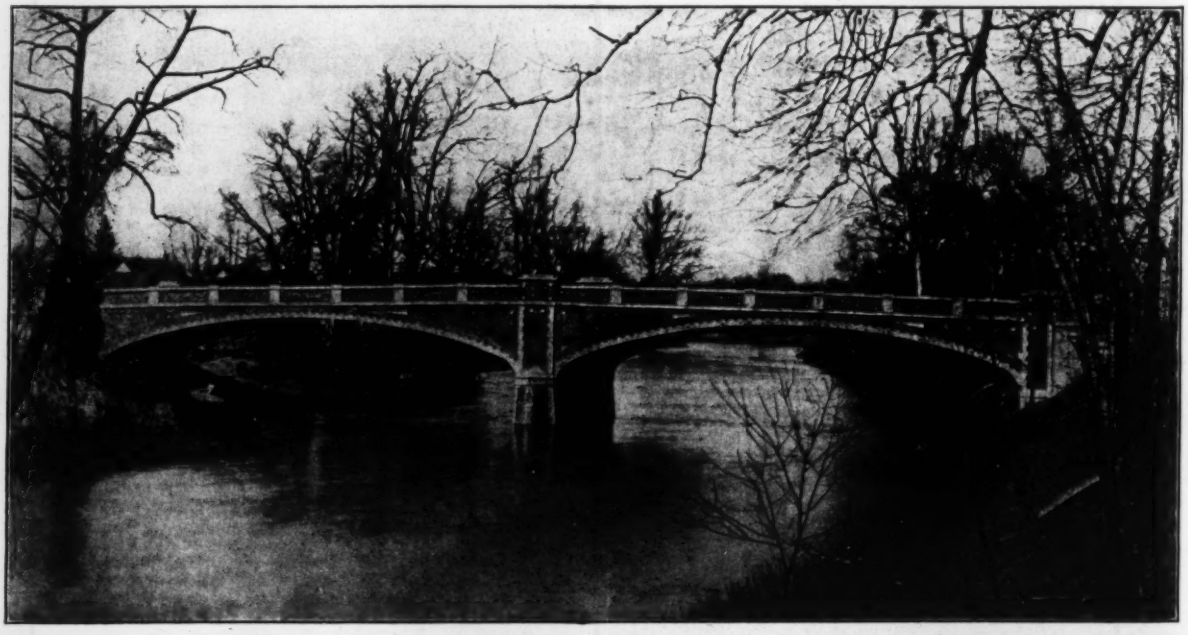


Fig. 1. Tennessee Ave. Bridge, Ft. Wayne, Ind.
(Brick facing with stone trim)

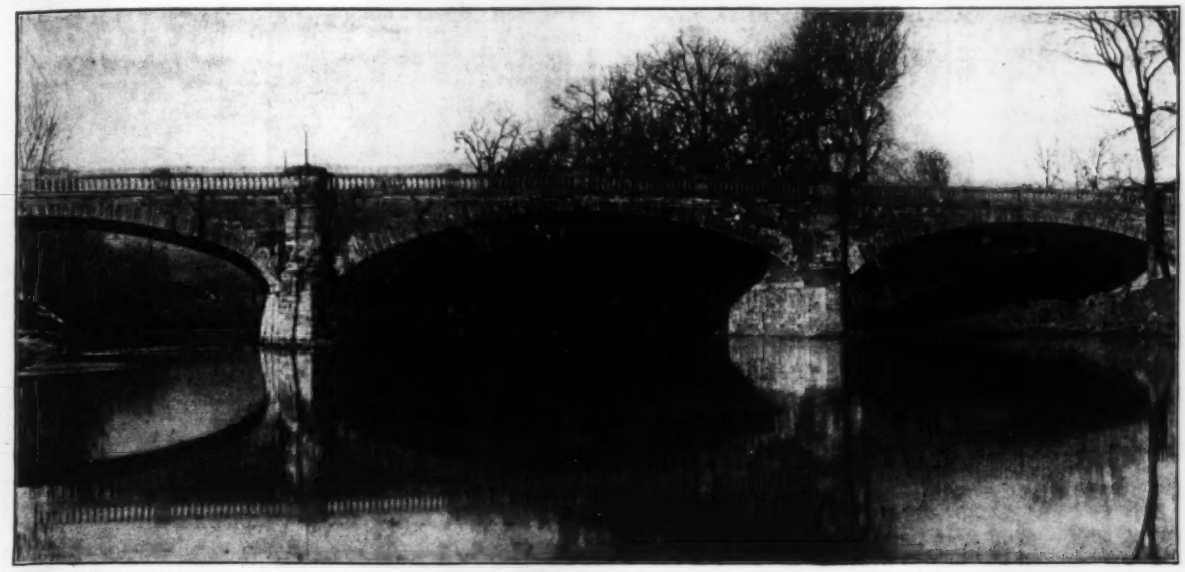


FIG. 3. COOMBS ST. BRIDGE
(Sandstone facing, concrete balustrade)

The bridge is said to have been built to curves sketched empirically to fit lines traced from drawings of the Tennessee Ave. bridge, under the following curious circumstances:

According to Indiana law, the county must have plans to accompany the advertisement for the letting of a bridge, and any person may submit a plan provided it is filed with the auditor ten days before the bids are opened. When the county commissioners of Allen County were ready to let a contract for the Coombs St. bridge they accepted plans drawn by a man who had been employed as carpenter foreman on the construction

FIG. 4. ROADWAY SUMMIT AND CONCRETE BALUSTRADE, COOMBS ST. BRIDGE

of the Tennessee Ave. bridge. His plans were drawn without any study to determine the necessary size of the various parts of the structure, but from a cardboard templet which he made of the arch curve of the Tennessee Ave. bridge from contract drawings of it on file in the county commissioners' office. The radii of the arch ring of the Tennessee Ave. bridge were changed to make a curve suitable, in his mind, for the new spans.

Construction brought out both the amusing and the serious features of the design. In the Tennessee Ave. bridge the two spans are each 105 ft. long, while in the Coombs St. bridge the channel span is 100 ft. long, flanked on each side by a 90-ft. span. When forms were laid out by the contractor for the Coombs St. bridge, using radii shown on the plans, each span failed by about 2 ft. to connect up with the masonry it was to rest upon. So he and his foreman made full-sized arch-ring templets, pretty much by eye, that would spring over the foundations. Their curves reduced the waterway below what it would have been if proper elliptical curves had been used. The templets were taken to shops in Fort Wayne and Melan-type arch ribs bent to fit them.

Not only was the design of the arch curves defective, but in the plans of the Melan trusses a serious omission occurred, due to ignorance. The ribs were made in three sections, but no top and bottom flange plates were provided at the joints where the angles butt. In other words, at the two points of approximate maximum stress the flange connections containing two-thirds of the rivets at the joints were omitted.

⁂

San Francisco Specifications for Concrete Pavements—Some interesting points in the specifications for concrete pavements, written by M. M. O'Shaughnessy, City Engineer of San Francisco, and recently adopted by the Board of Supervisors, follow: The concrete is of 1 : 2 : 3½ mixture. After mixing, the concrete is deposited rapidly in successive batches; the concrete is deposited to the required depth and for the entire width of the pavement in a continuous operation between transverse and longitudinal joints without the use of intermediate forms or bulkheads. In case of a breakdown, concrete must be mixed by hand to complete the section or to an intermediate transverse joint placed at the point of stopping work. Any concrete in excess of that needed to complete a section at the stopping of work is not to be used in the work. Longitudinal joints filled with ½ in. of prepared felt are constructed between the curb and the pavement on each side of the roadway, and along the center line where the roadway exceeds 25 ft. in width. Transverse expansion joints are constructed in straight lines at right angles to the center line of the roadway for the full width of the pavement and at intervals not exceeding 25 ft. The surface of the pavement is sprayed with water as soon as the concrete is sufficiently hardened to prevent pitting and is kept wet until a sand covering is placed. As soon as this can be done without damaging the concrete, the surface of the pavement is covered with a layer of sand at least 1 in. thick, and covering kept moist for at least 10 days. The pavement is not to be opened for traffic for a period of at least 20 days after being laid. The contractor is required to maintain the sand covering for a period of at least 10 days and must erect and maintain barriers to protect the concrete from traffic, and any part of the pavement damaged by traffic or other causes prior to its official acceptance must be repaired or replaced by the contractor at his own expense in a manner satisfactory to the engineer.

Rail-End Connections for Bascule Bridges

A special design of mitered joint for the rail connections of bascule drawbridges has been in use for about three years at the Calumet River bridge of the Chicago & Western Indiana R.R., and is described briefly in a paper in *Bulletin 175* (March, 1915) of the American Railway Engineering Association. It was designed by W. A. Casler, Assistant Engineer of the railway.

The design was made after a study of the merits of square-cut and miter-cut rails, and a special feature is that it brings the rails into line regardless of the alignment of the bridge. The bridge alignment in this case is found to vary as much as ½ in. in summer, owing to warping. In the usual type of mitered or lap joint there is a possibility of the rails interfering or becoming jammed while closing, unless a very wide joint spacing is provided. Such a spacing is objectionable, as in connection with the decreased tread surface it causes severe pounding at the joint, and the consequent wear reduces the life of the connections. These objections are overcome in the design described. The main parts are manganese-steel castings, each forming in itself the track rail, guard rail and joint at the bridge connection.

The lifting ends are provided with guiding members, cast on the under side. These are tapered at the lower portion and then straight for a distance slightly greater than the height of the running rails. These guides enter pockets on the abutment, and thus bring the rail ends into line before the rails engage during the closing of the bridge.

The abutment rail ends are riveted to a bedplate made in two parts, these being put together with an insulated joint to permit the use of track-circuits for the signals. The bedplate has openings to receive the taper guides, with short heavy angles beneath the openings to form the sides of the pockets for the guides. This arrangement permits of a very close miter joint, as noted.

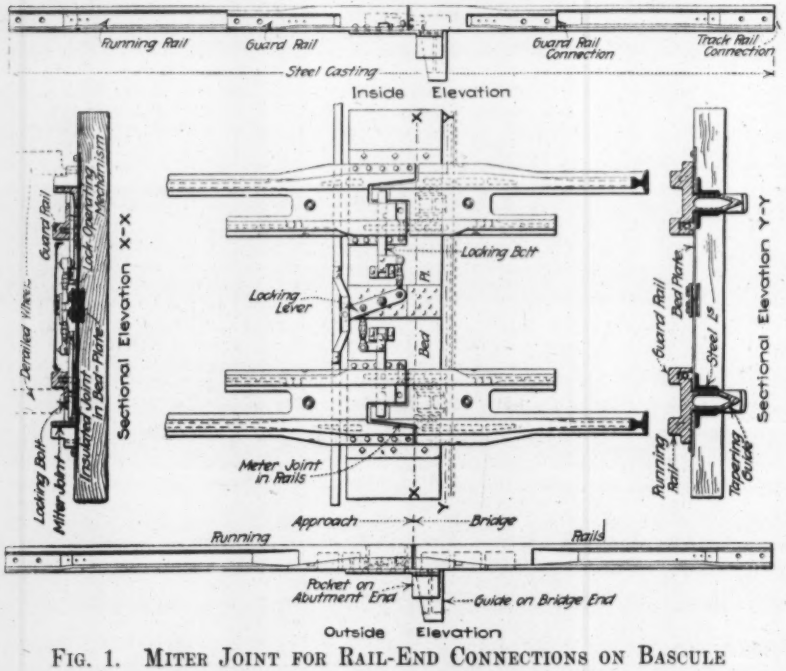


FIG. 1. MITER JOINT FOR RAIL-END CONNECTIONS ON BASCULE BRIDGES; CHICAGO & WESTERN INDIANA R.R.

The locking is effected by horizontal sliding bolts which engage the flanges of the lifting ends and hold them down upon the abutment bedplate. Automatic latches prevent the movement of the bolts when the bridge is open. The locking bolts are operated by a lever pivoted in the center line of the track and connected to a switch-operating motor mechanism, controlled by the interlocking plant for the signals and derails.

FIG. 2. MITER JOINT FOR RAIL-END CONNECTIONS ON BASCULE BRIDGES; SHOWING THE CONTINUOUS GUARD RAIL AND THE FLOOR TO CARRY DERAILED WHEELS OVER THE JOINT

Another feature of the device is the protection afforded to derailed trains. In Mr. Casler's opinion more attention should be given to guard-rail equipment at drawbridge connections and to the elimination of mechanism in the path of derailed wheels. It will be seen from the illustrations that in this case the guard rail is maintained continuously opposite the rail joint, and with a flange-way support to carry derailed wheels on their flanges. The locking bolts and operating mechanism are also protected from damage due to derailment. The device permits of using the 8-in. guard-rail spacing employed on fixed bridges, while some other devices require a 10-in. spacing. It is considered that a derailment at such a point would be no more dangerous than if it occurred upon a fixed bridge having the usual guard-rail protection.

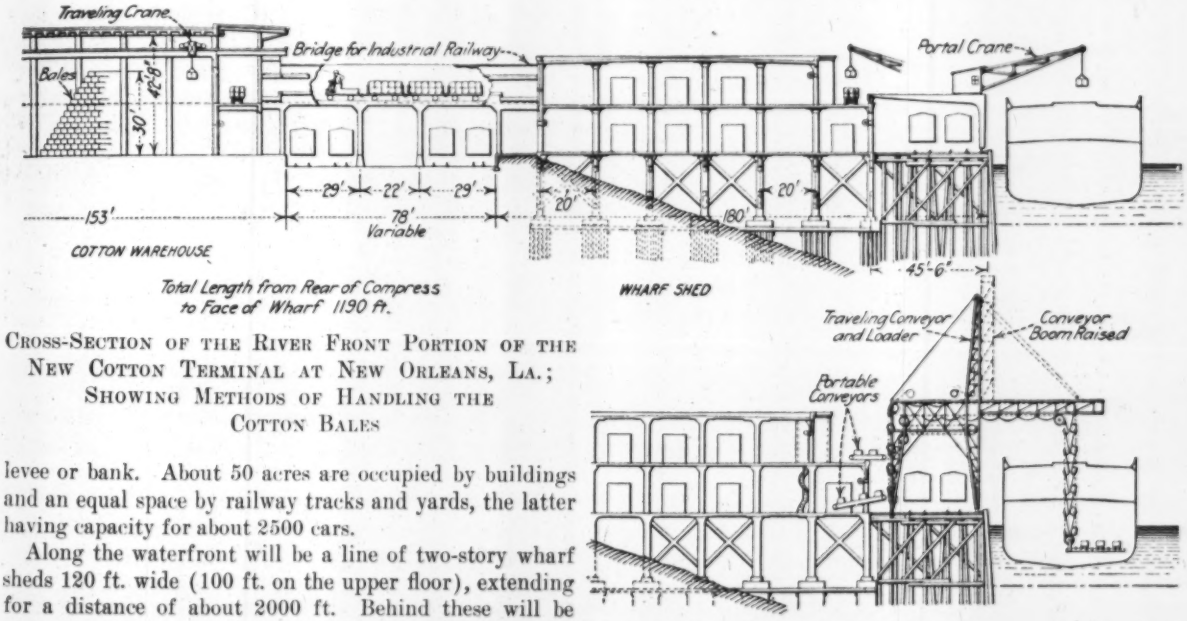
Mr. Casler believes that the mitered type of rail connection is superior to the square-end type. It gives

smoother riding and can be made safer and less liable to injury by derailments, since it can be made free of obstructions in the path of derailed wheels. This last feature is difficult to obtain in sliding-bar or sleeve joints, where the operating rods are either in the guard-rail troughs or immediately adjoining the outer rails.

Cotton Warehouse and Terminal at New Orleans

Extensive new facilities for the cotton-shipping business at New Orleans, La., are being built by the Port Commission. These comprise a warehouse and terminal plant with capacity for storing nearly 500,000 bales and for handling and shipping about 2,000,000 bales annually, while future extensions are planned to double this capacity. The plant was designed by Ford, Bacon & Davis, consulting engineers, New York, and the work is being done under their direction. The designs were made with the coöperation of representatives of the Cotton Exchange. The Jefferson Construction Co., of New Orleans, has the contract for the buildings.

The site is on land reclaimed from the Mississippi River by hydraulic dredges pumping material behind a levee or bank. About 50 acres are occupied by buildings and an equal space by railway tracks and yards, the latter having capacity for about 2500 cars.



CROSS-SECTION OF THE RIVER FRONT PORTION OF THE NEW COTTON TERMINAL AT NEW ORLEANS, LA.; SHOWING METHODS OF HANDLING THE COTTON BALES

Along the waterfront will be a line of two-story wharf sheds 120 ft. wide (100 ft. on the upper floor), extending for a distance of about 2000 ft. Behind these will be a group of four warehouse buildings (in pairs) 670x270 ft., with tracks laid between them. Next to these will be two sorting sheds, 670x130 ft. At the rear will be a cotton-compress building, 410x230 ft., flanked on either side by a warehouse, 510x270 ft. The buildings will be of reinforced-concrete and steel-frame construction, with creosoted-pile foundations. In front of the wharf sheds will be a timber wharf of creosoted piles and timbers. This will have two railway tracks for cars delivering cotton direct to vessels, and on it will travel dock cranes and conveyors which span the railway tracks and deliver bales from the sheds to the vessels.

The warehouses are of the one-story cellular, or compartment, type, 35 to 45 ft. high, with no intermediate floors. This arrangement greatly reduces the cost, since all the load is carried directly upon the ground and all load-carrying floors and columns, with their foundations, are eliminated. The cost is said to be about $4 per bale, as compared with $10 per bale if the floor type of warehouse had been adopted. For handling and transporting the bales in the compartments there are overhead traveling cranes and hoists. Special hoisting devices are provided also, by which a bale can be taken from the bottom of a pile without removing the bales above it.

For handling the bales from cars to the warehouses and from warehouses to the wharf sheds there will be a system of narrow-gage industrial tracks on which small cars will be operated by electric locomotives. These tracks will be on the level of both floors of the wharf sheds, being connected by inclines and the upper-level tracks being carried on runways extending between the buildings. The bales delivered on either floor of the wharf sheds will be transferred to ships or lighters by means of portal cranes with revolving booms or by traveling conveyors.

An Employee May Use His Technical Knowledge gained in the service of an employer in connection with work for a competing employer after he leaves that service, notwithstanding a direct agreement to the contrary. This is the substance of a decision recently rendered by the Court of Appeal of Great Britain. As described in London "Engineering" of Apr. 9, the case was that of an engineer who had been chief draftsman of a manufacturing firm and later was placed in charge of its sales department. While in that position he made a contract with his employer that he would not for the term of seven years from the date of his relinquishing employment with him go into the business of manufacturing or selling pulley blocks, overhead runways, overhead traveling cranes, or any parts thereof. Notwithstanding this agreement, the engineer after leaving the employ of this company entered the service of a firm which was its chief competitor. The former employer appealed to the court for an injunction. The case was heard by the court and the judge ruled that the enforcement of the agreement would deprive the defendant and the public of the benefit of the skill and experience he had acquired in the plaintiff's employment and would prohibit him from using knowledge which formed part of his mental equipment. The case was carried to the Court of Appeal but this affirmed the judgment of the lower court. One reason the latter court gave for its decision was that the defendant at the time of signing the contract was not really in the position of a free man negotiating on equal terms with his employer, but was bound by a previous agreement made in 1906 for seven years.

Interstate Bridge Over the Columbia River, Portland, Ore.

By E. E. Howard*

SYNOPSIS—Bridge and approaches, construction of which is just being started, will extend across the Columbia River valley from the city limits of Vancouver, Wash., to the city limits of Portland, Ore., a distance of about 3¼ mi., and will include about 5000 lin.ft. of steel bridge structure and 12,000 ft. of embankment, with a secondary approach on the Oregon side, for which at the present time an embankment about 6000 ft. long will be built. The bridge and approaches will provide a roadway for street traffic and for street cars, and over the steel structures will provide a sidewalk. The Columbia River at times of extra-high water covers the entire 3-mi. width of the valley. The total cost is to be about $1,700,000.

The main channel of the Columbia River at Portland, Ore., is 3500 ft. wide, with a maximum depth of 30 ft. at extreme low water, and with variations from extreme low to extreme high water of 33 ft. The water rises each spring to about 20 ft. and about once in four years to about 25 ft. So far as known, it has reached 33 ft. only once. The bed of the river consists of sand, with small amounts of gravel extending to great depths. At the north shore very compact cemented gravel is found a few feet below the surface, dropping off to 100 ft. below at about 700 ft. from the north shore. Over the remainder of the river only sand with some gravel was found at depths of more than 100 ft.

The Oregon Slough forms an important secondary channel, particularly for flood conditions. It is about 1000 ft. wide and 25 ft. deep, and is separated from the main river by an island about 1500 ft. wide. The United States Government has built a dike some distance above the bridge site and the island to divert practically all of the low-water flow down the main channel of the river, the top of the dike being about 6 ft. above low water. The bed of this slough is principally sand.

The Columbia Slough provides some drainage near the Oregon side of the valley and is about 300 ft. wide and 20 ft. deep at low water. The bottom is of clay and sand. Hard and compact gravel is found about 80 ft. below low water.

The average elevation of the ground across the river valley is from 12 to 15 ft. above low water, so that much of it is inundated at every high-water period.

*Harrington, Howard & Ash, Consulting Engineers, Kansas City, Mo.

Bridge Structure

The roadway is 38 ft. wide between curbs, or 41 ft. between trusses, with steel handrails where required. Over the steel spans there is one sidewalk 5 ft. wide. Double-track street-car tracks for both standard and narrow gages are placed in the middle of the roadway, spaced 10 ft. 8½ in. c. to c. The vertical clearance in trusses is 21.5 ft. The entire roadway, both on the bridges and embankment, is to be paved with hard-surface pavement.

The live-loads for which the structure is designed are as follows:

For floor system:
On street-car tracks—50-ton cars on both tracks.
On roadways—12-ton motor truck, Class A, uniform load with special provisions for 24-ton machinery truck.
On sidewalk—120-lb. per sq.ft.

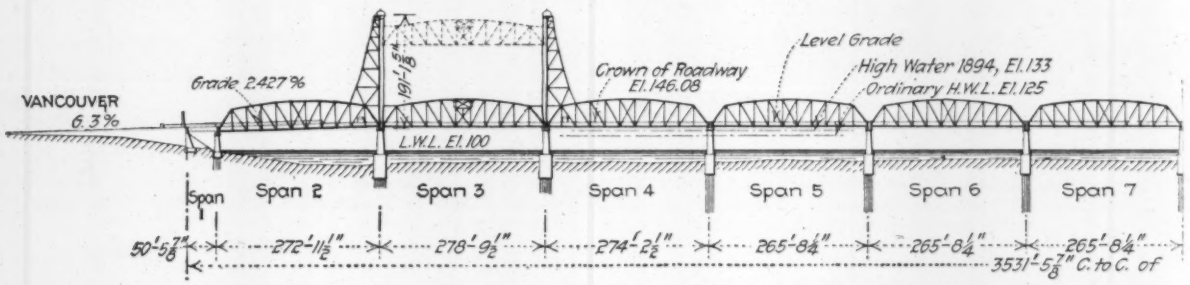


FIG. 1. OUTLINE ELEVATION OF THE

For impact allowance, 50 per cent. is added to all except sidewalk loads.
For trusses and girders:
On street-car tracks—40-ton cars on both tracks.
On roadways—Class B uniform load.
For impact allowance the following percentages of each load is added to it:

For street-car loading—$I = \frac{230}{N L + 300}$, but not greater than 50 per cent.

For roadway loading—$I = \frac{180}{N L + 30}$, but not greater than 50 per cent.

Where
I = Percentage;
L = Length of load on bridge producing maximum stress;
N = Number of loaded tracks for street-car loading or number of lines of traffic for highway loading.

The working stresses used in the design are as allowed by Harrington, Howard, and Ash specifications.

Main Truss Bridge

The bridge over the Columbia River (Fig. 1) consists of a series of through riveted truss spans with curved top chords, three spans 275 ft. long and ten spans 265 ft. long, together with a small deck-girder span at the Vancouver end, making a total length of 3531 ft. 5⅞ in. between end shoes. Provision for navigation on the river is made by a vertical lift span of the Waddell & Harrington type. The central of the three 275-ft. spans is arranged to lift between towers on the other two, so as

to afford a channel 250 ft. wide at right angles to the current of the river and 150 ft. high above ordinary high water.

The trusses are spaced 41 ft. c. to c. with the roadway between and the sidewalk beyond one truss. The floor is

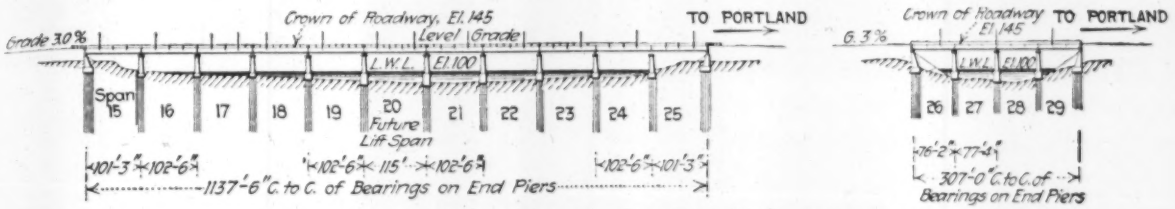
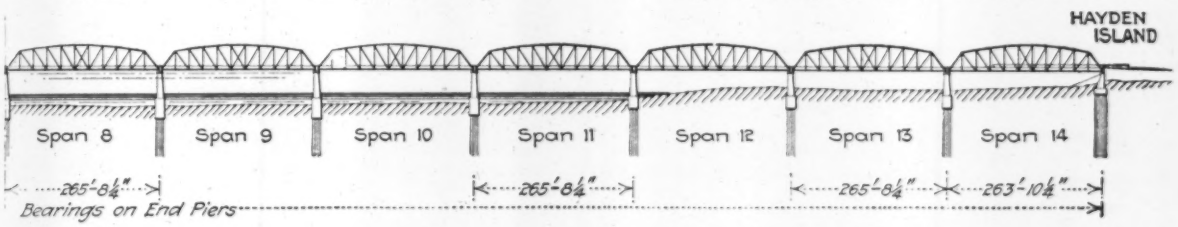


FIG. 2. OUTLINE ELEVATION OF THE TWO SLOUGH CROSSINGS

a reinforced-concrete slab 5¼ in. thick, and the sidewalk is also of reinforced concrete. The arrangement of the beams and of the concrete slab for the floor merits attention, as it is new and original (Fig. 3). Between usual floor-beams are longitudinal stringers spaced about 9 ft. c. to c. On top of the stringers, extending entirely across the roadway, there are 8-in. I-beams spaced about 33 in. apart. These roadway cross-beams are bent to conform to the crown of the roadway, and the concrete slab rests immediately on top of them. The six rails required for the two-gage, double-deck street-car tracks rest immediately upon the roadway cross floor-beams and are fastened to them by standard Carnegie steel tie clips. The rails are 7 in. high, so that there remains a space of 2 in. in



MAIN TRUSS SPANS, INTERSTATE BRIDGE

depth above the top of the concrete slabs to the top of the rail for the 2-in. special bituminous concrete surfacing which forms the pavement. To afford a rail heading which could be removed, if necessary, for access across the rails, or to the bonding, without injury to the roadway slab, the space, about 5 in. wide, on each side of each rail, is filled with concrete to the top of the rails, a flangeway being provided by forming this concrete.

This arrangement of floor has the advantage of providing a concrete slab longitudinal in the direction of travel, with comparatively short spans, and of making the supporting steel beams of very simple shop work. It is expected that the cross floor-beams will be formed to their curve by shimming up the hot-beds to a proper curve, so that the beams may form while cooling. Owing to the lateral stiffness of the floor as constructed, the lower laterals of the spans are somewhat lighter than they would be for an open-deck bridge.

Two fixed ends and two expansions of the spans are placed adjacent so as to reduce the number of expansion joints to a minimum. The expansion joints are made by the usual type checkered plates supported by and sliding upon metal supports. The corresponding expansion joints for the rails between the spans consist of manganese-steel castings placed beside webs of the rails, for which one side of the rail heads is planed off.

The towers supporting the lift span are of simple construction, riveted throughout, and so arranged that the front columns of the towers support all the loads of the lift span and counterweights. The rear columns are bracing members.

SUBSTRUCTURE

The river at the site of the bridge is subject to a certain amount of scour, but inspections of the soundings taken for many years past fail to disclose any indication of scour to extreme or unusual depths, although the river for some distance upstream and about three miles downstream is deeper than at this site. The exceptional facilities for securing piles of great length at a very reasonable cost were a considerable factor in determining the exact type of piers to be used.

The piers (Fig. 4) are to be constructed of concrete, containing and resting upon piles sunk by means of water jets to a depth of about 105 ft. below low water. Open cribs of timber, braced by transverse trusses and forming permanent parts of the pier bases, will be sunk to depths of from about 20 to 25 ft. below the river bed and the piles jetted down inside the cribs, averaging about one

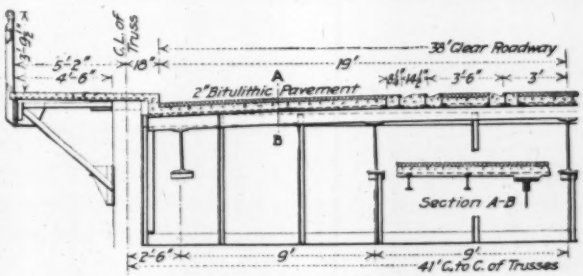


FIG. 3. DETAILS OF FLOOR-BEAM AND ROADWAY, INTERSTATE BRIDGE

pile to 10 sq.ft., area of crib. Concrete will then be deposited through the water in sufficient quantities to seal the bottom of the crib; and after this concrete has hardened the crib will be pumped out, the piles will be cut off a short distance below low water, and the remainder of the concrete for the pier placed in the open. A certain

amount of heavy stone riprapping will be placed about the piers, and will be replenished, if necessary, during the first two years after the completion of the structure.

The piles used will thus be about 120 ft. long in single sticks, about 10 or 12 in. in diameter at the top and about 22 in. at the butt. No followers will be used in driving, but the necessary cutoffs will be wasted. Piles of this length can be purchased at the bridge site for about 12c. per lin.ft. In the average piers under the 265-ft. span there are 90 piles.

The upper ends of these piles are embedded into the concrete of the base of the piers from 15 to 20 ft., so that the pile forms a definite portion of the pier. It is evident that even though some unusual scour should on some extraordinary occasion extend below the bottom of the base, the pier would still be stable, owing to the great depth of penetration of the piles and to the rigidity of

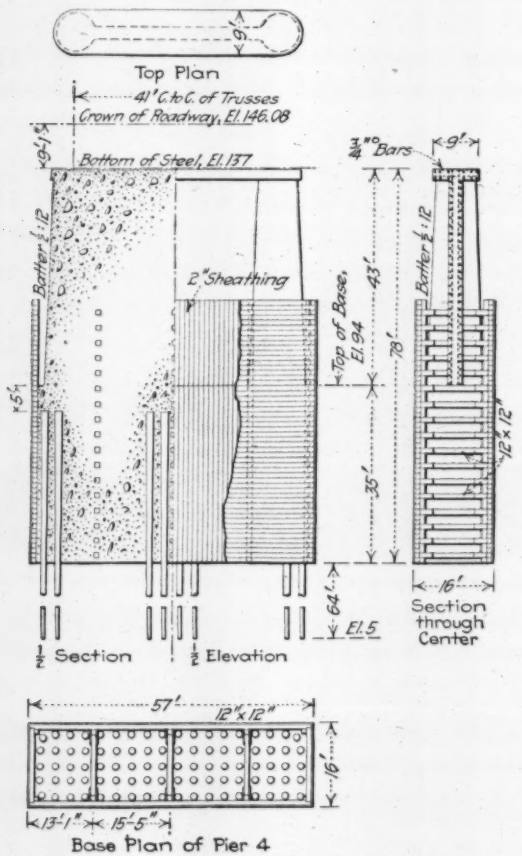


FIG. 4. TYPICAL PIER ON INTERSTATE BRIDGE ACROSS COLUMBIA RIVER, PORTLAND, ORE.

their upper support. The occurrence of ice on the Columbia River in sheets or floes of large size is very rare, so that the concrete piers need no special protection of steel or stone facing.

The shafts of the piers above the base are composed of two cylindrical battered columns, one placed under each pair of shoes. These columns are joined by a vertical diaphragm and by a horizontal coping at the top, both of which are reinforced with steel. This design saves considerable weight, which otherwise would require supporting piles, and eliminates a large amount of concrete unnecessary for any structural purpose.

SLOUGH CROSSINGS

The bridges over the sloughs (Fig. 2) consist of deck spans providing a roadway and floor of the same type and character as previously described, except that the girders are placed 23 ft. apart transversely and a portion of the roadway and sidewalk is carried on cantilever beams. There are also other minor differences in details, such as necessary trolley poles, etc. These spans rest on concrete piers supported by piles of the same general type as that described for the main river. The piles will be sunk to about the same depths, but as the likelihood of scour is much less in the sloughs, the bases are not carried as far below the river bed.

The bridge over the Oregon Slough consists of ten deck-girder spans 100 ft. long and one span 115 ft. long, making the total length 1137 ft. 6 in. At the present time there is no navigation in the Oregon Slough above the site of the bridge, but as there is possibility of navigation being developed above the site, it was necessary to provide for some type of movable span to furnish the necessary channel openings for vessels. Permission was secured from the War Department to build the structure with all fixed spans at the present time, with the provision that one span be so arranged that at any time in the future, when it may become necessary, it can be converted into a movable span by providing towers at each end and by equipping it with machinery, counterweights, etc., so that it may be operated as a vertical lift span. The 115-ft. span previously mentioned is arranged for such possible use and will afford a channel 100 ft. wide. This provision and arrangement save the commission an expenditure at the present time of about $30,000 and permit a movable span to be provided when necessary without discarding any parts of the present structure and without interrupting traffic.

The bridge over the Columbia Slough consists of four deck-girder spans, each 75 ft. long, of the same general type as that described for the Oregon Slough. After the first tentative approval of the plan for this slough bridge was given by the War Department the status of this slough was changed so that there has become a remote possibility that it may at some time be considered navigable. It has therefore been agreed that should such development occur one of these 75-ft. spans will be made to lift in the same manner as described in the foregoing, providing a clear channel opening of 60 ft. in width.

EMBANKMENTS

In the main approach on the Oregon side there will be about 1,000,000 cu.yd. of embankment and on the secondary approach there will be about 500,000 cu.yd. The embankments will be made of sand dredged probably from the Oregon Slough. The material will be lifted by suction dredges and will be transported to position through pipes. For the main fill there is being installed a 24-in. suction dredge, with electrically operated pumps, which will deliver the material about 5000 ft. At this point there will be installed a booster pump, also electrically operated, so that for the extreme end of the approach the material will be carried through about 10,000 ft. of pipe. The embankments are to be 42 ft. wide on the top, with slopes of 2 to 1, and average 20 to 25 ft. high.

The upstream side of the embankment will be protected to an elevation of about 20 ft. above low water by concrete slabs laid on the slope of the finished embankment. Here

slabs are to be 4 in. thick, reinforced with wire mesh and in strips of about 8 ft. wide, extending continuously up and down the slope. The overflow of water, which at times inundates most of the river valley, is largely back water and has very little perceptible current, except that caused by its outflow from the river over the land as the river rises and that caused by its return flow to the river as the river falls. The period of most rapid current, with corresponding danger of erosion, is when the water is just rising above the surface of the ground and when it is falling to its lowest point. The concrete protection part way up the slopes will therefore guard against erosion at these periods. It is planned to sow the remainder of the slopes with grass seed, in an effort to develop a compact sod covering the sides.

The embankments will be paved with some form of hard surface paving, the exact character of which has not yet been decided. As they will be principally of sand pumped into position, it is expected that there will be almost no settlement, so that the pavements may be constructed in time for the completion of the rest of the bridge.

Contract Details

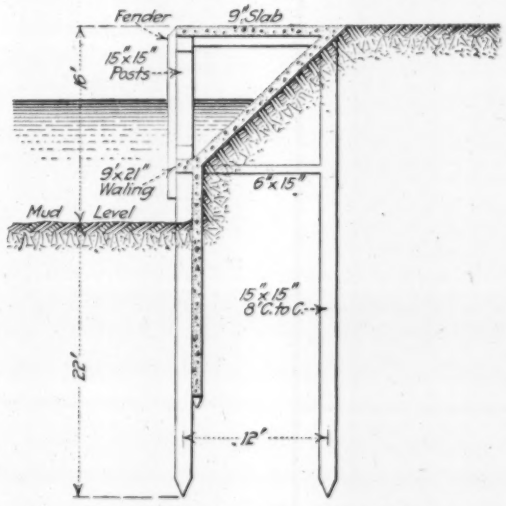
The consulting engineers prepared complete detailed plans covering every feature of the structure and very complete and definite specifications for every part. Bids were called for on the unit basis to be compared upon basis of the approximate quantities of the various materials as given in the specifications. In order to secure the best possible competition, the total contract was divided into twelve units and into such divisions as seemed naturally applicable. Bids were received on Feb. 23, 1915, and contracts were let soon thereafter to six bidders. The manufacture and delivery of the superstructure metal work for the main river bridge are in the hands of the United States Steel Products Co. The manufacture and delivery of the superstructure metal work comprising the girders of the Slough bridges is in the hands of the Northwest Steel Co., of Portland, Ore. The erection and painting will be done by Porter Bros., of Portland. All the substructure work is in the hands of the Pacific Bridge Co., of Portland. The concrete floor will be placed and the pavement laid by the Warren Construction Co., also of Portland. The construction of the principal portion of the embankments and of the concrete protection on them will be done by the Tacoma Dredging Co., of Tacoma, Wash., and the second embankment will be built by the Standard American Dredging Co., of Oakland, Calif. Contracts for the lighting system and for the pavement upon the embankments have not yet been let. The large number of duplicate spans and the careful manner in which the spans were detailed warranted the manufacturers of the steelwork in making exceedingly low prices. These features likewise contributed to securing a very low price for erection. The successful bids on the structure are to be given in the Construction News Supplement to Engineering News of July 1, 1915.

The erectors are planning to erect, rivet and paint the spans on a dock at the shore, to transfer them to barges, and to float them to position on the piers without the use of falsework. The contracts covering the total construction were let for about $230,000 less than the money provided, so that the commissioners were able to arrange immediately for the construction of the secondary approach previously mentioned, to accommodate a portion of the city not immediately adjacent to the principal approach.

The work of the various contractors has been arranged in order of time, so as conveniently to work together, that various operations may proceed consecutively and without interruption. It is expected that the bridge will be in service late in the fall of 1916. The engineering work is being handled in the name of the old firm of Waddell & Harrington; E. E. Howard and L. R. Ash are associated as Consulting Engineers. The bridge is being built under the direction of the Columbia River Interstate Bridge Commission, comprising the commissioners of Clarke County, Wash., and of Multnomah County, Ore. Multnomah County issued $1,250,000 of bonds and Clarke County, $500,000.

New Quaywall at Southampton, England

A new reinforced-concrete quaywall, recently completed in tidal waters at Southampton, England, is described in *Concrete & Constructional Engineering*, May, 1915. The design, shown in the accompanying section, consists of two rows of piles carrying a continuous deck and joined together by ties and by an inclined slab holding back the fill. The piles were first driven to refusal on 8-ft.



Reinforced-Concrete Quaywall

longitudinal centers and behind the outer row was driven a line of sheetpiles. All of the piles were then broken down to a level and capped with longitudinal wales on the outside row and cross-ties leading from outside to inside rows. On the pile caps and wales were then formed the vertical posts carrying the deck and sloping slab retaining the earth fill.

The section comprises forty-three 8-ft. bays and is of reinforced concrete, thoroughly tied together as to members. The dimensions are shown in the drawing.

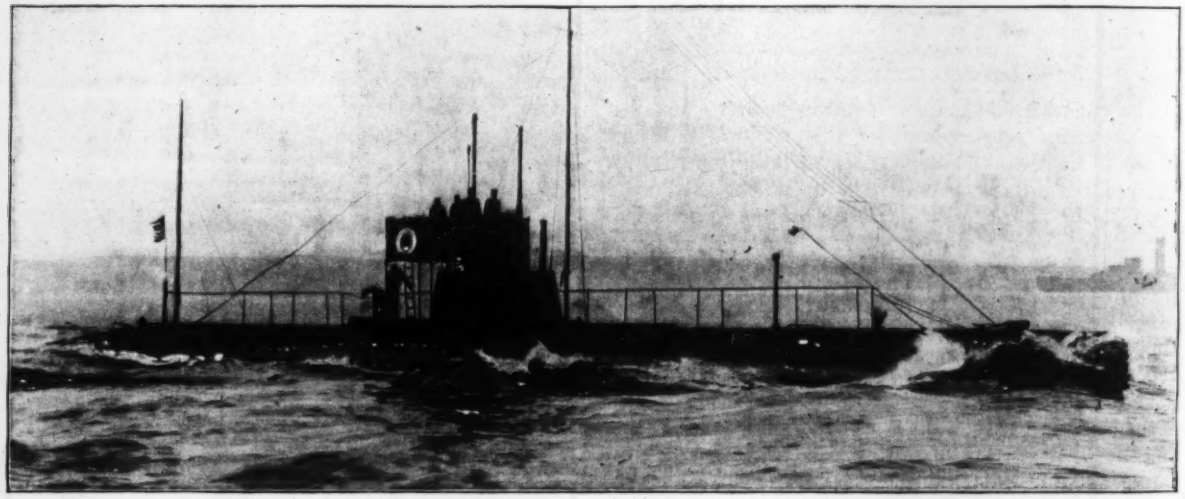
Reciprocal Liability Insurance for public-utility companies is being furnished by the Utilities Indemnity Exchange, of St. Louis, Mo., with a reported reduction of 40 per cent. in the cost to member companies. The members deposit each month sums about equal to the rates of stock companies. Out of the funds thus accumulated the losses and running expenses are paid, the latter being limited to 30 per cent. At the end of each year the unexpended sums are returned to the members. To guard against very heavy losses for which funds are not available the exchange reinsures the possible losses above the total of deposits.

Modern Submarine Torpedo Boats of the United States and Other Navies

By Herbert S. Howard*

Submarines in the present war have come so much to the front that not only navy men but the laymen throughout the country are evincing great interest in them. The questions which most frequently come to the front seem to be: How do they submerge? How deep do they go? How do they see? How fast can they go? How is it that German submarines can go away over into the Irish Sea or other waters about England and return to Germany? Do they carry guns as well as torpedo tubes? And very often: Are our submarines as good as the German submarines we read of?

In the first place, submarine boats must be strongly built, as they must withstand the pressure of water when they are submerged. For this reason the structure of submarines is heavy when compared to surface vessels, and must be made of a shape capable of resisting high pressure. It is the practice in all countries to design submarines to withstand submergence to depths of 150 to 200 ft., and beyond such depths they must not go.



United States Submarine Torpedo Boat E2

To submerge a submarine boat, water is admitted to ballast tanks, thus destroying the reserve buoyancy of the vessel. When it is desired to bring the vessel to the surface, water is pumped or blown by compressed air from these tanks. In some types of submarines these tanks are located within the main hull, which is circular in section. In some other types the tanks are located outside of the circular-section hull, between it and a light exterior hull, more or less ship-shaped. Our submarines and those of England are practically all of the first type, while those of Germany and France are of the latter type. In all submarines, however, water is taken in to submerge.

When submerged, submarines ordinarily receive no fresh air, and a submarine may remain submerged for about 10 hours before the air becomes too foul for breathing. In many foreign submarines devices for regenerating the air are fitted, to permit them to remain submerged a much longer time, and it is worth noting that devices of this nature have been tested and are now under consideration for the submarines of our navy. When running submerged the submarine is supplied with one or more periscopes, with which it can see, provided the vessel is only a short distance below the surface. These are optical instruments with lens systems similar to those of a telescope, but with prisms at the top and bottom to turn the rays of light down, and out at the bottom. When completely submerged, however, the submarine is blind. Various forms of searchlights, etc., have been suggested for under-water vision, but so far none have promised success.

Speed in submarines is a feature much sought after. Due to limitations of electric power, size of battery, etc., the submerged speed cannot at present be brought to a high figure. In modern submarines this varies from 9 to 11 knots, and this speed can be maintained for only one hour. If a slower speed is used, the distance covered will be greater, but the maximum submerged radius of a modern submarine will probably be 100 miles at 5 knots.

Surface speed offers greater possibilities of development and increase, and along these lines all countries are now working. For several years 14 knots has been considered about a maximum, but with development in oil engines, greater speeds have been attained. Some of the English submarines in service make 16 knots, and some German submarines 17 or 18 knots. At the present time, however, both in this country and abroad, there are submarines building of 20 and 21 knots speed. In such vessels steam or Diesel engines are used. None of these fast vessels are in service, so that it remains for the future to show whether they will usurp the place of the torpedo-boat destroyer. The radius of action of a modern submarine on the surface varies from 2500 to 5000 miles, so it may be seen that long trips are possible.

All modern submarines carry torpedoes as their essential armament. In general it is foreign practice to fit two or more tubes in the bow and two in the stern, while in our navy we have adhered to a bow arrangement with two to four tubes grouped there together. To fire these torpedoes, the periscope must of course be exposed and the vessel herself pointed at the enemy. It is not always

*Naval Constructor, United States Navy Yard, Washington, D. C.

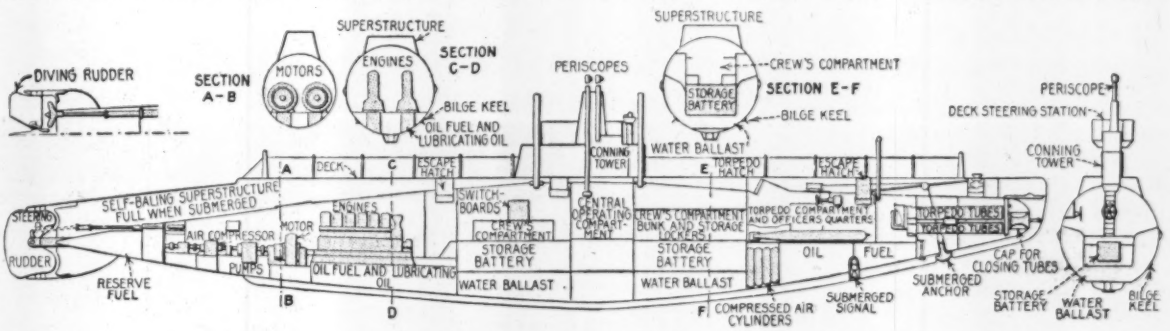
realized, and so may be worth noting, that the torpedo itself is really a small submarine boat with high-powered engines. With modern torpedoes, speeds of from 35 to 40 knots are obtained, with ranges up to 4000 yd. or more. Submarines, however, usually fire their torpedoes at ranges of from 600 to 2000 yd. In addition to torpedoes, submarines nowadays generally carry one or two small guns, and the use to which such guns may be put has been brought out clearly in the present war.

It is often thought that a submarine is a mass of machinery and that the life on board is simply existence in a whirl of shafts, levers, etc. A submarine is indeed filled with machinery and the crew are mechanical experts; but the quarters provided for the crew are as good as those on a torpedo boat. Bunks are furnished for all the men; electric ranges are installed for cooking food, and everything is done to make these vessels habitable and comfortable as far as possible for comparatively long cruises. For example, fuel, supplies, fresh water, etc., can be carried by modern submarines to make a cruise of 5000 miles. This is a fact not generally realized.

A modern submarine—and this applies to our own as well as other navies—is a vessel displacing about 450 tons on the surface and 600 tons submerged. The surface speed is from 13 to 15 knots and the submerged speed from 10 to 11 knots. Such a vessel would be 150 to 160 ft. long. Within the boat a certain space is taken by ballast tanks, for as I have stated water is admitted to destroy the buoyancy and to permit the vessel to submerge. The remainder of the space is given up to engines, electric storage battery and motors, torpedoes, crew's quarters and central operating compartment. In this last-named space are grouped the important means for controlling the vessel—the controls for flooding ballast tanks, the air connections for blowing water out of them, the wheels for controlling the steering rudders and the diving rudders, and the periscopes.

When the boat is to submerge, all the deck gear is taken down and all openings in the hull are tightly closed before water is admitted to the tanks. When the boat is running on the surface of the water rail stanchions are fitted, a small bridge is rigged, radio masts are hoisted, and the submarine becomes a small cruising vessel.

In our navy we have kept pace with the world in submarine development. Most of our submarines are of about the size and type described in the foregoing; but in addition we are building at present one large submarine of about 1000 tons surface displacement and of about 20 knots speed, and appropriations for two more such vessels were recently made by Congress. This program parallels those of England, France and Germany, which, in addition to their submarines of 400 or 500 tons surface displacement, are also building submarines of from 1000 to 1100 tons and of from 20 to 21 knots speed.



SECTIONS OF TYPICAL SUBMARINE TORPEDO BOAT OF THE HOLLAND TYPE
(From a published drawing)

Growth of London Passenger Traffic

The marvelous development in passenger traffic in American cities since the introduction of the electric street car is closely paralleled by the development in the principal cities of Europe. London *Engineering*, in its issue of Apr. 30, presents the accompanying table of passenger traffic in Greater London. From the figures in the table it will be seen that the passenger traffic of Greater London substantially doubled in the years from 1906 to 1913. This growth was due to the increase of the habit of travel far more than to actual increase in population.

During the first fifty years of the nineteenth century the population of London grew at an average rate of a little over 30,000 per year. In the latter half of the century, however, the increase was very much more rapid, reaching nearly 95,000 per year in the last decade of the century. In the first decade of the twentieth century the rate of increase dropped to 67,000 per year, the explanation of this being the extensive development in this period of suburban districts beyond the boundary lines of Greater London. The enormous expansion of omnibus traffic in very recent years has been coincident with the introduction of the motor omnibus in place of the horse-drawn vehicle.

PASSENGER TRAFFIC IN GREATER LONDON

	Number of Passengers Carried (1 = 1000)					
Year	By Railway (Local Companies)	By Tramway (Approximate)	By Omnibus*	Total (Approximate)	Estimated Population of Greater London 1 = 1000	Number of Journeys per Head
1867	40,547	Not available	41,424	81,971	3605	22.7
1871	72,636		43,556	116,192	3885	29.9
1876	115,326		51,157	166,484	4303	38.6
1881	139,233	72,038	58,389	269,662	4766	56.6
1886	165,050	132,529	90,708	388,289	5182	74.9
1891	180,026	198,569	158,926	537,521	5633	95.4
1896	189,584	279,518	212,628	681,732	6124	111.8
1901	236,506	340,772	269,933	847,212	6581	128.7
1906	329,521	508,700	291,563	1,129,784	6908	163.5
1907	356,233	589,745	330,000†	1,275,979	6975	182.9
1908	399,666	636,009	340,000†	1,375,675	7043	195.3
1909	410,744	687,138	311,000†	1,408,883	7112	198.1
1910	425,271	763,797	298,000†	1,487,069	7181	207.1
1911	436,498	821,819	340,669	1,598,987	7251	220.5
1912	436,492	797,487	492,858	1,726,839	7321	235.8
1913	462,019	811,397	733,931	2,007,348	7393	271.5

* The omnibus figures are incomplete. They relate only to the principal companies.

† The figures for these years are based on receipts, and are probably underestimated.

Riensch-Wurl Sewage Screens, Brooklyn

As noted on p. 1095 of the issue of June 3, construction work has been begun on the sewage-treatment plant of the 26th Ward, Brooklyn, N. Y. It is to be equipped with two 6,000,000-gal. Riensch-Wurl sewage screens. The specifications were so worded that one of several methods of treatment would be acceptable to the city. The specifications and plans were prepared on a competitive basis permitting the use of Imhoff tanks or sedimentation tanks with separate sludge-digestion and sludge-drying beds for either of the tank plants, and Riensch-Wurl fine screens. The exact wording of the specifications was as follows:

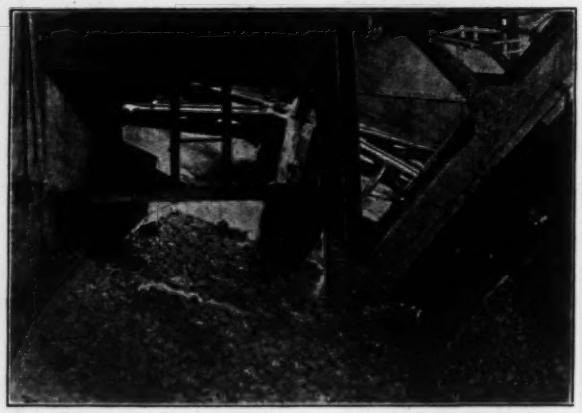


FIG. 1. SEWAGE-TREATMENT PLANT, DRESDEN, GERMANY

(View of a section of a Riensch-Wurl screen in service, showing screenings coming under the action of the brushes; also showing the construction of the screen seal)

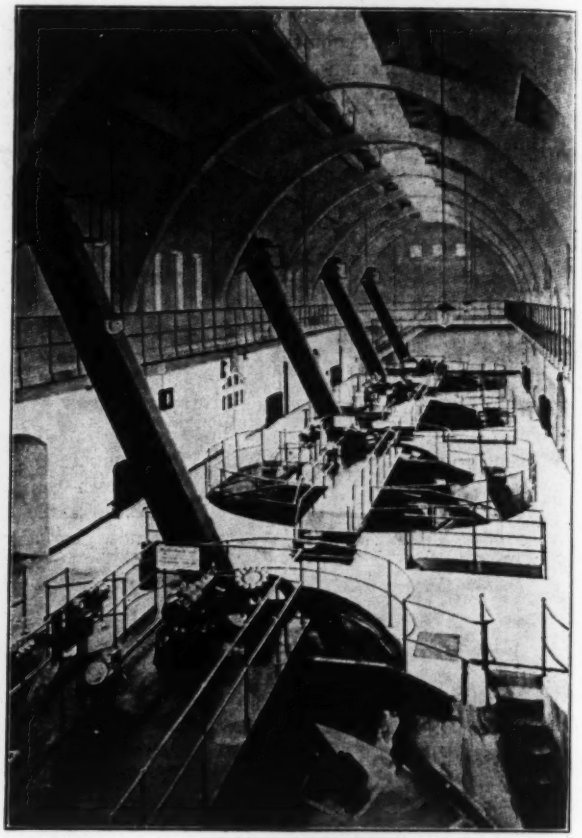


FIG. 2. SEWAGE-TREATMENT PLANT, DRESDEN, GERMANY

(Interior view of the screen house, showing general arrangement of the Riensch-Wurl screens (each 26 ft. 3 in. diameter). The two screens to be installed in Brooklyn are 14 ft. in diameter)

> The contractor shall install complete and ready for operation a plant for the purpose of removing suspended solids from the ordinary dry-weather flow of sewage at the 26th Ward disposal plant, Borough of Brooklyn, in accordance with one of three methods and designs for removing suspended solids shown on the plans of the work. The contract gives him the option of installing one of the following three methods and the plant for operating same:
>
> Optional Project A.—Riensch-Wurl screens, with direct removal of screenings.
>
> Optional Project B.—Imhoff tanks with drying beds for sludge.
>
> Optional Project C.—Sedimentation tanks with separate sludge-digestion tanks and sludge-drying beds.
>
> Either of the plants mentioned will be equally satisfactory to the city if it secures the results in removing suspended solids from sewage hereinafter set forth as the general requirements to which the plant installed must conform.
>
> When operating under average ordinary dry-weather conditions the plant shall be of sufficient capacity to treat 12,000,000 gal. of sewage per day.

A number of bids were received. The contract was awarded to the lowest bidder, the North Eastern Construction Co., which proposed to use Riensch-Wurl fine screens to fulfill the requirements of the specifications. The work is now under construction and the plant will be in

PARTIAL LIST OF RIENSCH-WURL FOREIGN INSTALLATIONS

No.	City	State	Remarks
1	Graudenz	Prussia	Municipal Sewage Plant
2	Dirschau	Prussia	Municipal Sewage Plant
3	Dirschau	Prussia	Municipal Sewage Plant
4	Ostrowo	Prussia	Municipal Sewage Plant
5	Strasburg	Prussia	Municipal Sewage Plant
6	Culm	Prussia	Municipal Sewage Plant
7	Goerltz	Prussia	Municipal Sewage Plant
8	Wreschen	Prussia	Municipal Sewage Plant
9	Strehlen	Prussia	Municipal Sewage Plant
10	Eberswalde	Prussia	Municipal Sewage Plant
11	Ragnit	Prussia	Municipal Sewage Plant
12	Herford	Prussia	Municipal Sewage Plant
13	Lissa	Prussia	Municipal Sewage Plant
14	Cologne	Prussia	Municipal Sewage Plant
15	Stettin	Prussia	Municipal Sewage Plant
16	Neuwid	Prussia	Municipal Sewage Plant
17	Osterode	Prussia	Municipal Sewage Plant
18	Marienburg	Prussia	Municipal Sewage Plant
19	Dresden	Saxony	Test Plant
20	Dresden	Saxony	Municipal Sewage Plant
21	Dresden	Saxony	Municipal Sewage Plant
22	Dresden	Saxony	Municipal Sewage Plant
23	Dresden	Saxony	Municipal Sewage Plant
24	Dresden	Saxony	Private Sewage Plant
25	Reichenau	Saxony	C. Lindemann Private Sewage Plant
26	Zittau	Saxony	Power House
27	Mainz	Hessia	Test Plant
28	Mainz	Hessia	Municipal Sewage Plant
29	Lauterbach	Hessia	Municipal Sewage Plant
30	Karlsruhe	Baden	Municipal Sewage Plant
31	Weida	Thuring	Otto & Albrecht Dix Leather Works
32	Ohrdruf	Thuring	Municipal Sewage Plant
33	Diedenhofen	Germany	Municipal Sewage Plant
34	Bremen	Germany	Test Plant
35	Bremen	Germany	Municipal Sewage Plant
36	Bremen	Germany	Municipal Sewage Plant
37	Bremen	Germany	Municipal Sewage Plant
38	Bremen	Germany	Municipal Sewage Plant
39	Bremen	Germany	Municipal Sewage Plant
40	Bremen	Germany	Municipal Sewage Plant
41	Christiania	Norway	Test Plant
42	Christiania	Norway	Municipal Sewage Plant
43	Christiania	Norway	Municipal Sewage Plant
44	Christiania	Norway	Private Sewage Plant
45	Petrog ad	Russia	Municipal Sewage Plant
46	Petrograd	Russia	Municipal Sewage Plant
47	Toulon	France	Municipal Sewage Plant
48	Petrograd	Russia	Peter the Great Hospital (Sewage)
49	Petrograd	Russia	Peter the Great Hospital (Sewage)
50	Astrachan	Russia	Municipal Sewage Plant
51	Memel	Prussia	Municipal Sewage Plant
52	Memel	Prussia	Municipal Sewage Plant
53	Greifswald	Prussia	Municipal Sewage Plant
54	Hamar	Norway	Municipal Sewage Plant

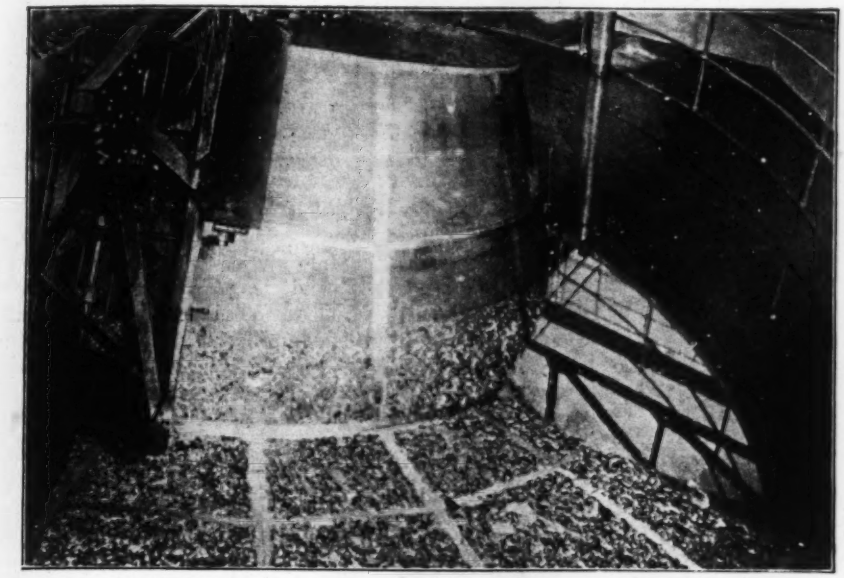


FIG. 3. SEWAGE-TREATMENT PLANT, DRESDEN, GERMANY

(View of a section of a Riensch-Wurl screen in service, showing the screen cone brushes and accumulation of screenings. The surface of sewage reflects the structural steel work. The clear portion of the screen cone is available for increased or storm water flow. One screen handles the entire normal flow at the station, of about 26½ million gal. per day)

operation this summer. The screens are furnished by the Sanitation Corporation, Philadelphia.

The accompanying views show the sewage treatment plant at Dresden, Saxony, in Germany, where there are several Riensch-Wurl screens in use. This is the most notable of the European installations.

A Large Gravel-Washing Plant

A sand-and-gravel washing plant, having the unusually large capacity of 100 carloads of washed material per 10-hr. day, has recently been put in operation by the Akron Gravel & Sand Co., of Akron, Ohio. The plant was designed and built by the Raymond W. Dull Co., of Chicago.

The material is excavated by steam shovels and brought to the plant by two trains, each consisting of a locomotive and two 30-yd. dump cars. One car of each train dumps from the bottom, and the other dumps from both sides, into a large concrete receiving hopper with capacity for about seven carloads. From the bottom of this hopper the material is delivered into an apron feeder 48 in. wide, operated by a variable-speed motor, geared directly to a worm-gear drive running in oil.

The feeder delivers the material into a 60-in. revolving screen that separates from the sand and gravel the stone which requires crushing. The stone is delivered to a large bucket elevator of special construction, the chains being built up of openhearth steel bars 4½x⅝ in. The chain pins and bushings are of chrome-nickel steel; the chain rollers are steel, and the sprocket wheels on the head and foot shafts have renewable manganese-steel teeth. The buckets are of the continuous type, 36-in. wide, reinforced by heavy steel lips.

This elevator discharges the stone onto a bar screen or grizzly, the larger stone going to a No. 6 Gates gyratory crusher and the remainder to a 48-in. Symons disk crusher. The product from each crusher is delivered to a 30-in. belt conveyor, which carries the crushed stone back to the 60-in. revolving screen for rescreening. The main conveyor from this screen is a 36-in. six-ply rubber belt, with ⅛-in. extra rubber cover on the carrying side, and is supported by troughing idlers.

The gravel washing equipment consists of 16 Dull inclined washing screens, mounted four in a row, with provision for two more rows, or 24 screens in all. There are eight 72-in. conical automatic sand separators or tanks. The screens and separators make five grades of material, which are delivered into seven bins.

Eight Skeletons were unearthed when the rock walls separating the workings of the Delaware & Hudson No. 1 colliery at Carbondale, Penn., from the old drift in which anthracite coal was first mined in this country were broken through on May 28. One of the skeletons was in a sitting position against the face of the coal measures and still wore miner's shoes. The mine records revealed that the bones were those of eight men who were entombed by a fall of rock Jan. 12, 1846.

GRAVEL-WASHING PLANT OF THE AKRON GRAVEL & SAND CO., AKRON, OHIO

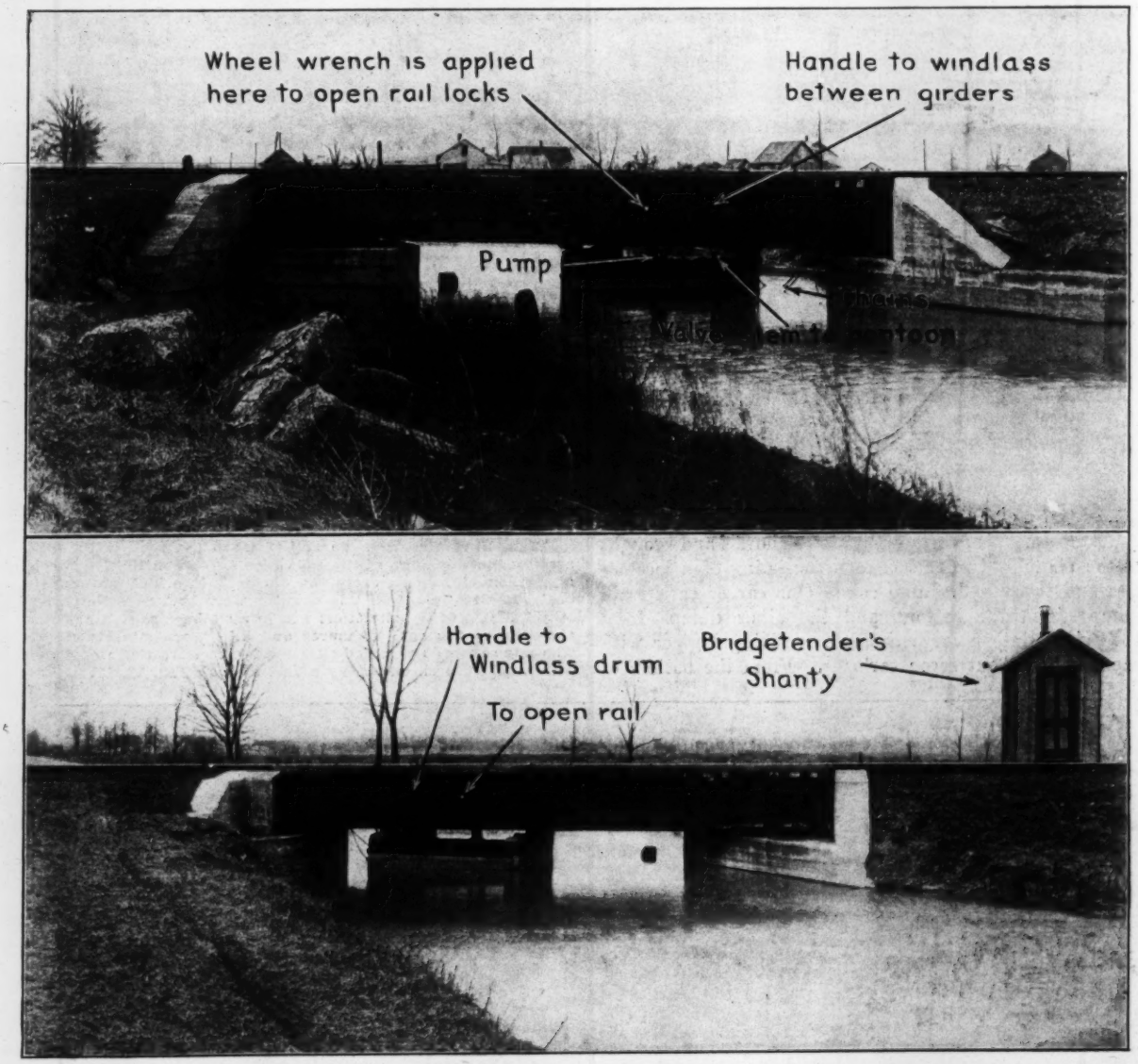
Field and Office

A Removable Fixed Bridge

Where the Nickel Plate railway crosses the Miami & Erie Canal, at Melrose, Ohio, a bridge was needed which would be, from the standpoint of the railway, a fixed span, but for canal traffic, a movable bridge. The view shows the structure put in. The canal is practically out of use; only repair and inspection boats have passed in recent years. Notice is given to the railway a few days before the boat is to come along, so that all may be made ready to open the bridge.

The structure is a pontoon swingbridge, but in normal position it is down on its end bearings, water being admitted to the pontoon. The procedure for opening the bridge is about as follows: The rail locks are opened; the lock-bars extending into recesses in the concrete backwalls are pulled clear, and wedges are released which hold the bridge $\frac{1}{16}$ in. above the circle rail at the fixed end. A gate-valve which admits water into the pontoon is then closed, and the pontoon is unwatered by means of a diaphragm pump (on the pontoon) until the girders are raised off at the movable end. A chain anchored on both banks passes over a windlass on the bridge, and by this windlass the bridge is now swung.

Opening and closing the bridge takes one man about half an hour, ordinarily.


Wheel wrench is applied here to open rail locks
Handle to windlass between girders
Pump
Handle to Windlass drum
To open rail
Bridgetender's Shanty

"Fixed" Pontoon Draw Carrying Nickel Plate over Miami & Erie Canal

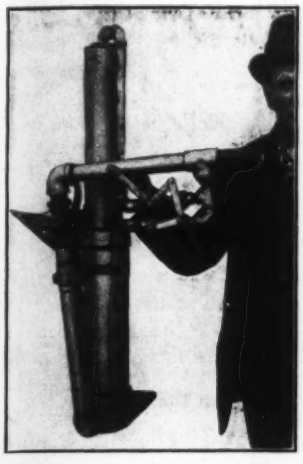
Railway traffic is protected by interlocking signals.

The bridge has been in place about 8 yr., and it has proved satisfactory to both railway and canal people, according to reports.

Compressed-Air Track-Surfacing Machine

In the maintenance of track a considerable amount of time and expense is expended on keeping the track in proper level, and it is not an easy matter to effect the smaller adjustments by ordinary tamping.

Several years ago a pneumatic surfacing machine was invented by the late E. L. Patterson, of Titusville, Penn., to avoid the disturbance of the bed of the tie by tamping. The machine had grooved wheels, to travel along the rail, and two vertical pipes—one carrying a hopper and the other connected to a compressor or a hand-blower. The pipes united at the bottom in a shoe having a thin flat horizontal nozzle. In using this machine the track was raised to the surface by jacks and the nozzle inserted under the ends of the ties in succession. With the air turned on, screened stone or gravel (not over ¾-in. size) was shoveled into the hopper and blown beneath the tie, filling all cavities and packing so solid as to support the track when the jacks were released. This machine was used on the New York, New Haven & Hartford and the Bessemer & Lake Erie roads, its work in the latter case being in connection with steel ties.



Machine for Surfacing Track by Compressed Air

A modification of this machine has been brought out recently by J. A. Royal, of Spruce Grove, Alta., and is shown in the accompanying view. It consists of two cylindrical chambers, the lower and larger one having a feed hopper at the top (shown at the left) and a discharge aperture at the bottom. Air hose from a compressor on a section motor car is coupled to the horizontal pipe at the right. The air is admitted at the top to drive down the ballast fed into the cylinder and at the bottom to blow out the ballast through the horizontal discharge opening. This opening can be fitted with nozzles of different size, to suit the ballast, and the machine can be used for lifts of ⅛ in. to 2 in. The weight is about 47 lb.

The inventor claims that surfacing can be done at the rate of 4 mi. per day with the following equipment and force: A motor car with air compressor and hose, eight surfacing machines (two working together on one tie), a foreman, eight machine men, four shovelers (each serving the two machines on a tie), one leveler, two jack men and two flagmen.

Blasting a Pit for a Dipper Dredge

By F. W. Wilson*

Two large ditches were to be dug recently in New Madrid County, Missouri. The contractor (The Hoosier Land & Investment Co.) owned two dipper dredges, but there was no basin in which to float a dredge in order to start the ditching. A pit was required 136x50x6 ft. deep. It was decided that this could be formed quickest by blasting. The hole was shot by a professional dynamiter.

Bore holes were put down, running the length of the proposed pit, in eleven parallel rows 3 ft. apart. The

*E. I. du Pont de Nemours Powder Co., Wilmington, Del.

Large Pit to Receive Dipper Dredge, Blasted by One Shot

holes in the middle row were each loaded with 2½ lb. of dynamite. The holes in the two rows on either side of the middle line were spaced 15 in. apart in the row and each loaded with 2 lb. of dynamite; the holes in the next two rows were loaded and spaced the same way. The spacing between holes in the next two rows was 2½ ft. and the loading 1½ lb. per hole; in the next two rows the holes were 2 ft. apart, and each was loaded with 1 lb. The holes in the two outside rows were spaced 18 in. apart and loaded with ½ lb. each. In all, 950 lb. of dynamite was used.

The result of the shot was a pit 43 ft. wide, 136 ft. long and 7 ft. deep in the center, with an average depth of 3½ ft., with the exception of one spot where a large cypress stump had stood and which caused the dirt to pile up. The blaster claims that he did not want to blast the pit in one shot, but the contractor wanted it done that way and so he acquiesced. The blaster's idea was to blast out two pits and then shoot out the division. By this method much less earth would have fallen back into the excavation.

The 600-Ft. Self-Supported Radio Towers at Darien*

By Ira W. Dye†

The United States Naval Radio Station at Darien, C. Z., is one of a chain of high-powered wireless-telegraph stations being installed by the United States Government under the cognizance of the Navy Department. The Darien station is located almost exactly half way between Colon and Panama and lies on the west side of the Panama R.R. and on the east bank of the Panama Canal. The Poulsen system of transmission is used.

The design of the three 600-ft. self-supporting structural-steel towers and the method of erecting them are the items in the construction work which are of primary interest to civil engineers. The towers are triangular in plan, the base being an equilateral triangle 150 ft. to the side. The columns are battered toward the center of the triangle so that at the 150-ft. level the side of the equilateral triangle becomes 75 ft.; at the 380-ft. level, 35 ft., and at the top, 10 ft. Fig. 6 shows that the framing is a system of horizontal struts at the panel points, the middle point of the horizontal strut in each face being joined to the end of the horizontal strut above by diagonal web members designed for alternate stresses. Each face of the tower may be considered as a cantilever truss anchored at its wider end (the base of the tower).

Structural Steel Members

The main columns of the lower part of the tower are built up of an I-beam, to the web of which are attached two angles and a web plate. The back of the I-beam is reinforced by a cover plate. The attenuation of the steel is as follows: Farther up the tower the cover plate is omitted; then the I-beam is reduced in section; the I-beam is changed to a channel; the flange angles and web plates are reduced in section; the channel is omitted; and in the last three panels at the top of the tower the web plate is omitted, leaving only two heavy angles back to back as a column section.

*The Darien radio station was designed, constructed and will be operated by an organization combining the forces of the Navy Department and the Panama Canal. The steelwork of the towers was furnished by the Pennsylvania Steel Co.

†Former Supervisor of Radio Stations, Panama Canal, C. Z.

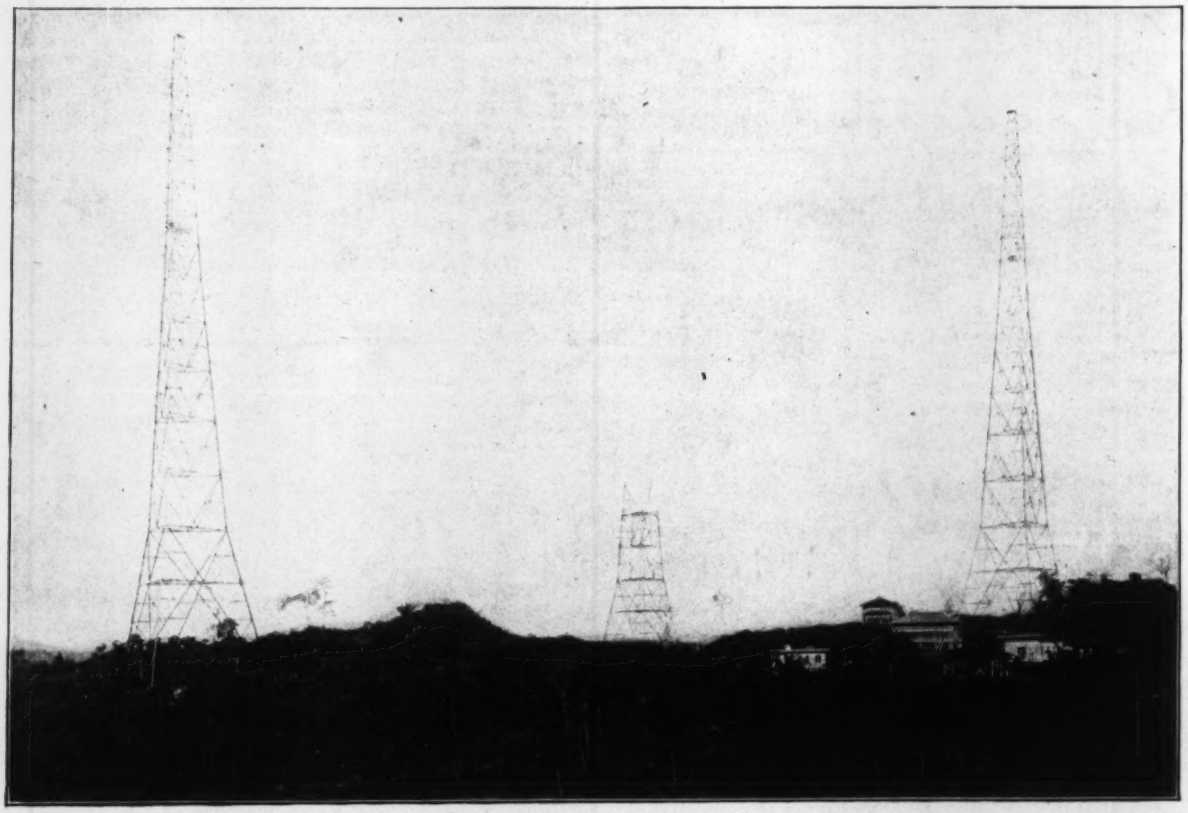
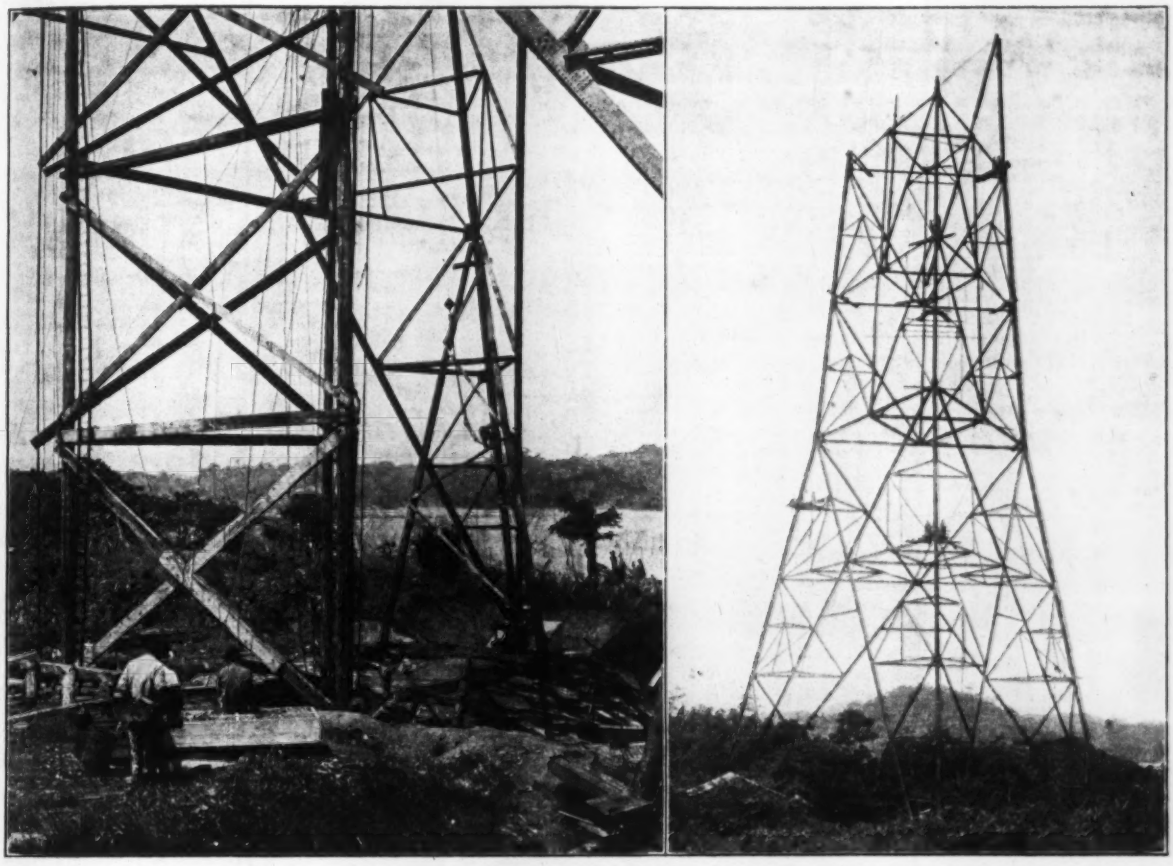


Fig. 1. View of Steel-Tower Layout at Darien, C. Z.
(Middle tower erected above 250-ft. level; other two towers completed)



FIGS. 2 AND 3. ERECTION SCENES AT ONE OF THE TOWERS
(Left—Outfit for erecting from ground to 200-ft. level. Right—Showing ginpole method of erection above 200-ft. level)

Web members are connected to the columns by gusset plates, bent where they leave the column so as to lie in the plane of the face of the tower. In the lower part of the tower these gussets are shop-riveted to the flanges of the I-beam. Above the 200-ft. level, however, the gusset plates are field-connected to the web plate of the column. The web members are for the most part star sections, built up of two angles set corner to corner and battened together with ⅜-in. batten plates spaced about 2 to 2½ ft.

The towers as erected show very little deflection, although all joints above the 150-ft. level were field-connected with bolts instead of being riveted.

TOWER-LEG INSULATORS

Provision was made in the design of the towers for their final support on a nest of large porcelain insulators (Fig. 5). The insulators had been tested in compression to 150 tons. For erection purposes, the towers were supported above the foundations* sufficiently to permit the subsequent installation of the insulators. These were placed on wood wedges, which were made with a very slight slope and were 14½ in. wide on the face. Two wedges were placed under each leg of the tower, each wedge consisting of an upper, lower and middle portion. The upper portion was protected against undue marring by the steel of the tower by being shod with a ½-in. steel plate.

*The foundation work for the three towers of the Darien station was described in "Engineering News," June 17, 1915.

The tower is not self-supporting until the 150-ft. level has been reached. At this level heavy horizontal struts transmit the horizontal reaction from each leg to the *other two.* It is, therefore, necessary to support the first 150 ft. of the tower in position, leg by leg, until all the members below this level have been erected.

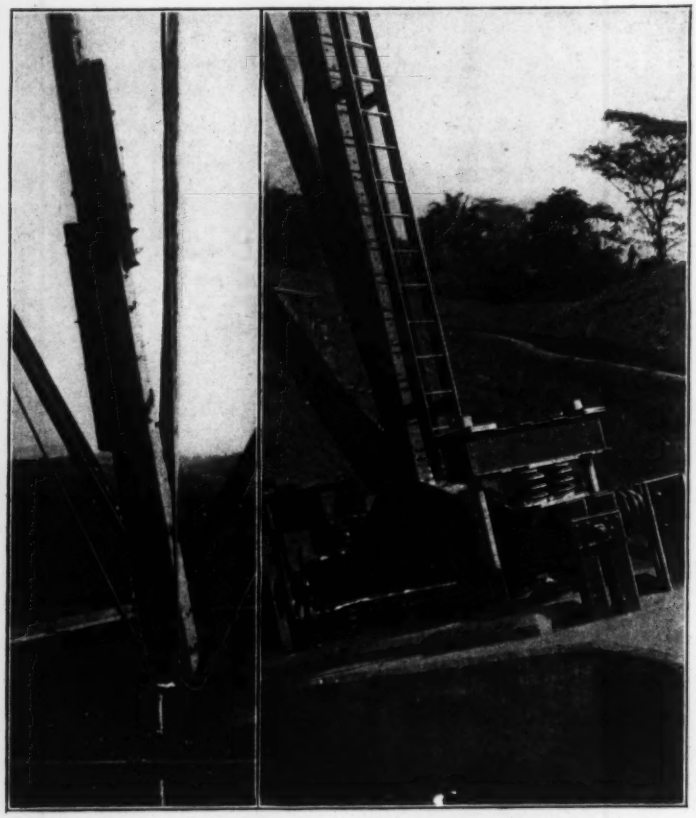
The first erection outfit used was a triangular tower (Fig. 2) 30 ft. on a side, with vertical legs. It was set up in the center of the site. On the top of the wood tower, composed of fir piles, 8x16-in. yellow pine and 4x12-in. sway bracing, was laid a circular track of 70-lb. rails. A stiffleg derrick was mounted on the track, the mast standing over a leg of the wood tower. The two stifflegs extended toward the two other legs of the derrick tower and were anchored down by cables passed over them and under a pile of steel members on the ground. The 60-ft. boom was rigged with a three-part boom tackle and a two-part load tackle, the fall line passing down the boom, around a sheave at the bottom of the boom and down the post to the hoisting engine. The reach of the boom was ample to set the first column sections of the tower, which were, of course, the members farthest from the center.

The first two columns, with a total length of 60 ft., were bolted together on the ground, each with the lower end in such a position that when the upper end was picked up, the column tipped back into its proper place on the foundation. It was then anchored on the wedges by means of anchor bolts, so that it would stand until an A-frame consisting of two 60-ft. piles latticed to-

gether with 4x12-in. timbers could be raised and secured underneath the column. The wood members up to the level of the top of the second column section were then erected; another column section was added, its web members filled in, and the tower thus brought up to the 100-ft. level.

The derrick was then moved around on the circular track until it was in position to erect the second leg to the 100-ft. level. At this level there is a system of horizontal bracing which, while not sufficiently stiff to support the tower without assistance, does aid the temporary A-frame shores. The third leg of the tower was then erected to the same level.

In a similar manner the columns and web members were carried up to the 150-ft. level, leg by leg, and then



FIGS. 4 AND 5. (LEFT) METHOD OF SUSPENDING 110-FT. ERECTION GINPOLE. (RIGHT) TOWER-LEG INSULATORS

to the 200-ft. level, which was the limit of the boom reach. The erection outfit was then taken down to be reërected at the next tower site. A new scheme of erection was started at the 200-ft. level.

This second scheme (Fig. 3) involved the use of a ginpole 110 ft. long. The ginpole was built up of a long, heavy pile of Oregon fir, spliced out at the lower end with two 8x16-in. and two 4x13-in. timbers, and at the upper end by two 6x14-in. timbers 35 ft. long. A 2-in. hole was bored into the lower end of the pole for about 2 ft. and a piece of 1½-in. pipe driven into the hole. A slot was then cut in the pole just above the end of the hole and in the slot an 8-in. sheave was fastened by a pin through a hole drilled from the outside, so that the circumference of the sheave was in line with the pipe. A second sheave was mounted in the slot so that it protruded just outside the surface of the pole. The fall line was run through the pipe around the inner sheave and back around the outer sheave, and was led up the pole to a top sheave pinned between the two 6x14-in. timbers. The line dropped from the top of the pole to

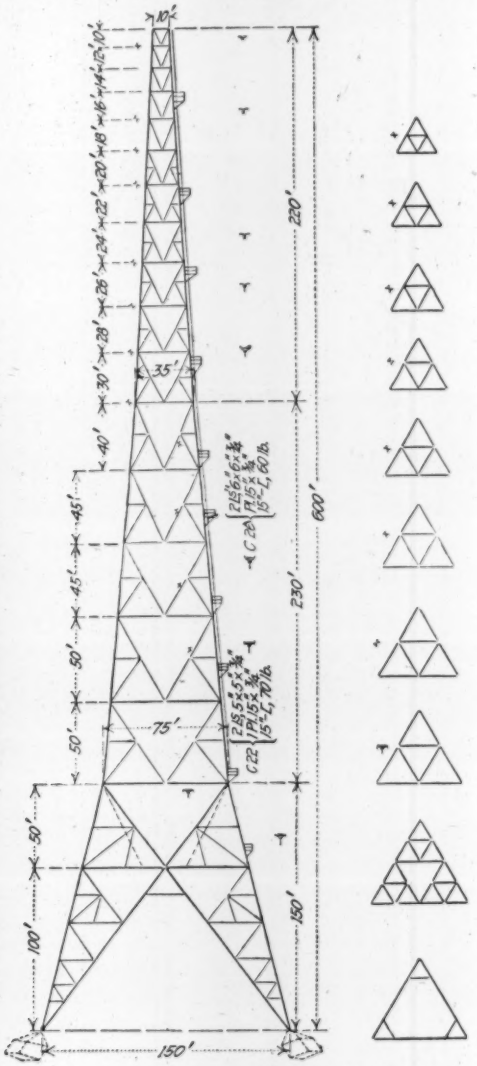


FIG. 6. DESIGN OF THE DARIEN TOWERS

the hook, and the other end led through snatchblocks to the drum of the hoisting engine.

The pole rested on a three-cornered steel saddle (Fig. 4), drilled in the center to admit the 1½-in. pipe in the bottom of the ginpole. A hole was drilled at each corner of the plate for attaching cables. The top of the pole was guyed by two-part manila-rope tackle, so that the top of the pole could be moved to any position inside the tower by adjusting the length of the guys. The suspender cables were of such length that the bottom of the pole hung at about the 150-ft. level. Its top was, therefore, at about the 260-ft. level, allowing 10 ft. of drift to set the next panel columns, which were 50-ft. long. The ginpole thus formed the axis of a double triangular pyramid, the lower apex of which could not be moved unless

LARGE DRAGLINE EXCAVATOR BUCKET DESIGNED BY E. R. SHNABLE FOR WORK ON CHICAGO DRAINAGE CANALS

the length of the suspender cables was changed and the upper apex of which could be moved at will by adjusting the guys. Steel was hoisted through the center of the tower.

When the ginpole had finished erecting the panel above its point of support it was raised by means of a 50-ft. ginpole resting near one of the columns, on the steelwork already erected, and was resuspended from the top of the panel just finished. This operation was repeated until all steelwork up to and including one panel above the 380-ft. level had been erected. The large heavy ginpole was then taken down and replaced by a similar one 60 ft. long, which finished the erection.

The horizontal web members not being supported at their middle points until the panel immediately above them was erected made it necessary to shore up these horizontals with piles resting on the middle point of the panel below. These shores were left in until the tower had been erected to the 380-ft. level. To this level the horizontal struts were spliced in the middle; but above this point they were continuous from column to column and capable of supporting their own weight. The same set of shores was used in all three towers, as were also the same falsework, derrick and ginpole.

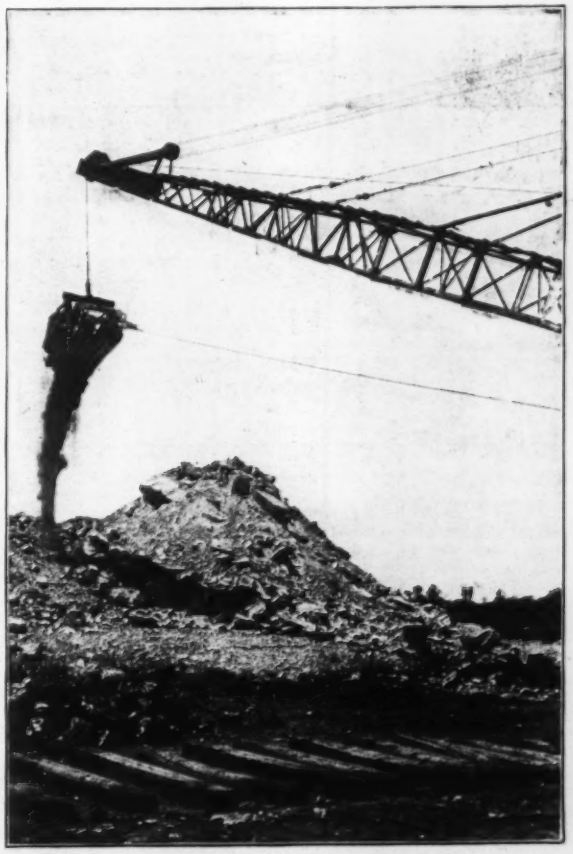
While the first tower was being erected from the 150- to the 380-ft. level, the second tower was being erected up to the 150-ft. level, and when the first tower was being erected above the 380-ft. level, the second tower was going up from the 150- to the 380-ft. elevation. The same schedule of progress was maintained on the second and third towers, so that when the top of tower No. 1 was being finished, work had just started on No. 3, while No. 2 had been erected above the 380-ft. level.

A Very Large Dragline Excavator

A dragline excavator of particularly large and rugged construction has been in use for the past five years on the construction of the Calumet-Sag and North Shore drainage canals at Chicago, Ill. The material excavated included a glacial conglomerate of sand, gravel and boulders cemented with clay and tightly packed, and below this a hardpan full of pieces and ledges of limestone. To be able to handle this material efficiently with a dragline excavator, E. R. Shnable, of Shnable & Quinn, contractors, designed and built the bucket shown in the accompanying illustrations.

It is a back-dumping bucket, and the tension on the dragline keeps the back gate closed. When the tension is released, the bucket, being suspended by the combination hoisting bail and back gate, tips and dumps by gravity. In the bucket's digging position the pulling or dragline bail is connected to the shell at points which are above the center of gravity of the shell. The pulling bail is also connected by links to the hoisting bail and back gate in such a way that the tension on the dragline forces the gate to close and remain so until the tension is released. The bucket is designed to have flexibility, and to prevent binding in any of the parts it has loose-fitting connections.

The operation of the excavator is entirely controlled by the two single-part lines, the dragline and the hoist line. When the bucket is filled, it is raised to dumping position at the end of the boom by pulling in on the hoist



DUMPING BUCKET BY RELEASING TENSION ON DRAGLINE

line and at the same time keeping a tension on the dragline. After the load is dumped the shell resumes its position automatically. No tripping device is required.

Parts of the bucket subjected to the greatest wear are constructed of four separate removable parts, any of which may be quickly renewed. These are the front section of the shell, the manganese-steel cutting plate, the teeth and the manganese-steel teeth points. The teeth are bolted to the cutting plate and have removable points.

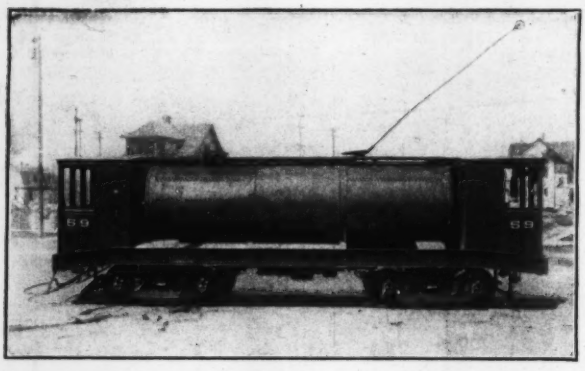
Owing to the way in which the dragline is attached it is possible to dig down a slope, although the dragline is pulling up. The same feature also makes it possible to cut off as thin a slice of earth as is desired by varying the pull on the hoist line. Both bails are short, which permits the bucket to be brought in quite close to the machine.

The patents on this bucket have recently been purchased by the Brown Hoisting Machinery Co., Cleveland, Ohio, and it has been placed on the market under the trade name of "Brownhoist Shnable" bucket.

NOTES

A Street-Railway Track Sprinkler of special design is shown in the accompanying illustration. It was designed by George L. Wilson, engineer of maintenance-of-way, and W. J. Smith, master mechanic, of the St. Paul City Ry. Co., and was built in the company's shops. The two spraying heads are just under the car sill at the rear (right); they are to be used for either water or a solution of calcium chloride. Under them is a spray pipe for oil.

In the rear cab, occupied by the sprinkler operator, are placed a Smith heater, an auxiliary air compressor and levers for controlling the discharge of the oil or water. The operator is provided with an air compressor for the oil spray independent of the air supply for braking purposes. The heater supplies hot water for a coil which runs through the tank, returning through the front cab, for keeping up the temperature of the oil or calcium chloride solution and for supplying heat to the cabs in cold weather. A steam coil is also provided, which is connected up in the yard to a steam plant, and the initial heat is supplied in this way for either the oil or calcium chloride solution. After the oil has been heated to the proper temperature or the calcium chloride fully dissolved, the necessary temperature is kept up on the tank while running by the Smith heater.



OIL AND WATER SPRINKLING CAR, ST. PAUL, MINN.

The car frame is of standard heavy construction, except that the end frames are bent down to give more headroom for the equipment in the cabs. The frame is mounted on two 2-motor trucks set 19 ft. c. to c. The car is intended to sprinkle a single track. The capacity of the tank is 4400 gal., which is sufficient to sprinkle a 19-ft. strip for 4 mi. In freezing weather a calcium chloride solution is used instead of water. The car is being used at present only on paved streets and has not yet been tried with road oil. The weight of the car is 52,100 lb.

Driving and Cutting Off Steel-Pipe Piles for the foundations of the new quarantine landing at Balboa, Canal Zone, Panama, is described in a recent issue of the "Canal Record." The cutting off of the tops of the piles to an even elevation was done with an oxyacetylene torch, which was able to cut some of the pipes, 14 in. in diameter and ⅝ in. thick, in 4 min. In driving the pipe it was necessary to fill them with concrete for about 2 ft. above the bottom of the end cap to weigh them to the sinking point. In order to give the piles the required batter, they were driven through a guide frame, built of timber and ballasted, which was sunk at the point of driving. After it was placed in approximate position movable guides were adjusted for the exact inclination. This frame, 24 ft. high by 20 ft. long and 12 ft. wide, was handled from place to place by a derrick barge which also operated a steam hammer to drive the piles. The pipe was afterward filled with reinforced concrete.

A Steam Shovel Worked Behind House Wreckers to clear ground and excavate for cellar and foundations of the new Mercantile Building to be erected on Broadway between 35th and 36th St., New York City. The revolving shovel shown in operation in the accompanying view was installed on May 24, as soon as a building at one corner of the site had been demolished. Since then the shovel has been worked as rapidly as the wreckers could tear down the other buildings.

STEAM SHOVEL EXCAVATING BUILDING WALLS, NEW YORK

The shovel is digging to a depth of 15 ft. below street level, and the soil handled is loam, clay, boulders, broken rock and broken building-foundations. The new building, which will be eight stories in height, will be founded on rock which at some points is at a depth of 15 ft. Where the rock crops out above this level it is drilled and broken up for the shovel. The Thompson-Starrett Co. is the general contractor; F. H. Chapman Contracting Co., subcontractor. The block is well known to New Yorkers. One of the buildings razed was the old Herald Square Theater.

Third-Tracking the Elevated Railways in New York City under traffic has made necessary an immense amount of field-work. Snare & Triest, one of the two steel erectors on this work, gives us some interesting data on its sections (on 8th and 9th Aves. above 65th St. and on 3d Ave. above 147th St.). Work on these sections began about July 1, 1914, and involved the erection of 6500 tons of steel and the removal of 1500 tons of old steelwork. Before the end of April of the present year 275,000 rivets had been driven by Snare & Triest, 260,000 holes had been drilled from the solid, 20,000 holes subdrilled and reamed, and 125,000 old rivets and bolts had been cut out. It is interesting to note that about 85% of the drilling and reaming was accomplished with electric drills. The motors of these drills are wound to stand a variable direct-current voltage of 550 to 650 volts. The "Duntley" drill, made by the Chicago Pneumatic Tool Co., was employed. In restricted quarters, air drills were used. Riveting was done with pneumatic guns. Steel for the 8th and 9th Ave. work was furnished by the Lewis F. Shoemaker Co.; steel for the 3d Ave. section was supplied by the McClintic-Marshall Co. It was stored at a yard in Greenville, N. J., and delivered by lighters, as required. Whenever material was needed, it was ordered out and lightered to the Pennsylvania R.R. dock at 128th St. and the Harlem River or to the Interborough Rapid Transit Co. dock at 125th St. and the Harlem River, from which points it was hauled to the site on trucks.

Editorials

Long Foundation Piles

Engineers in the Eastern and Middle States, where good timber has of late years become somewhat of a luxury, will read with amazement, touched with envy, of the long piles which are to be driven in the New Columbia River bridge, described on p. 1218 of this issue. Sticks 120 ft. long and straight and staunch enough to be driven as piles are only memories on the Atlantic Coast. That such sticks can be had on the Pacific to the number of nearly 3000 at a cost of only 12c. per lin.ft. is lively evidence of the abundance of our northwestern forests.

The long embedment of these piles is also novel, although not entirely new, as a similar detail was used in another Oregon bridge—the Coos Bay Bridge, described in ENGINEERING NEWS, Apr. 1, 1915, p. 609. Such a construction should undoubtedly add to the lateral stability of the pier and insure a uniform transmission of load, but will probably complicate somewhat the placing of the concrete, both above and below water. There is also the remote possibility that these many piles extending far up into the pier section may tend to cause planes of weakness through the concrete.

Preventing Telephone Troubles Along Electric Railways

The service interference to telephone and telegraph communication once met with in districts where alternating-current railways operated has been noted at various times in ENGINEERING NEWS, as well as some of the complicated attempts to mitigate it. The degree of elimination secured along the Elkhorn grade of the Norfolk & Western Ry., as noted elsewhere in this issue, illustrates the simplicity of the most successful methods. To cure the troubles—not merely to remedy them—it was necessary only to place the substations judiciously and to discourage the current from leaving the rails.

In fundamental respects these are the same lines along which the New Haven road reached success after a long period of bother with elaborate compensating devices. On this line the very simple expedients were adopted of (1) doubling the feeder voltage, (2) making the supply circuit include only the contact wires and high-tension feeders, and (3) placing numerous single-coil transformers across this supply circuit and connecting their mid-voltage point to the rails. In this way the track and trolley became active conductors only between the two transformers adjacent to a train. The traction currents were made to flow to the train from opposite directions, producing a second diminution of effect on parallel wires. The track current was restrained, more than before, from leaving the rails and cutting cross lots, so that the currents in trolley and track held parallel paths and tended better to neutralize their inductive disturbances. The main supply circuit, by losing its earth return, acted similarly.

The same recourse to fundamental measures of prevention may be seen in the electric-traction installation of the Pennsylvania R.R. out of Philadelphia, though of course the details are varied.

Value of Permanence in Public Service

In our issue of June 3 we referred to the important public service rendered to New York City by its Bureau of Franchises. It is of interest to put on record that one of the reasons why this bureau has been able to do such thorough and effective work in the protection of the city's interests is that its staff is made up of men of long experience in the city's service. Of the 17 employees in the bureau, 12 have been connected with it since its establishment in 1905, and their total time in the city's service ranges from 10 to 28 years.

A still more notable instance of long continuance in the city service is the very unusual record of David Brower, who has just retired from the Brooklyn Sewer Department after serving as an engineer in that department for 54 years.

So much has been published concerning the corruption of municipal government in the United States, and particularly in New York City, that many people still have the idea that most city employees hold their positions by virtue of political pull. It is well worth while, therefore, to put on record the above showing as an illustration of the fact that, notwithstanding the many changes in political control that have taken place in New York City in the past quarter century, a large proportion of those in the city's service continue on year after year without regard to political upheavals.

We are well aware that many contrary instances can be cited where engineers and others who have rendered valuable service to cities have been displaced for political reasons; on the whole, however, there has been a great improvement in this respect in our municipal governments during the past quarter century.

The enactment of civil-service laws is partly responsible for this, without doubt. Even more potent has been the realization, however, by every man who attains to any important position in governmental affairs that in order to get the public's work done in any sort of satisfactory shape men who know by experience what the work is and how it should be carried on must be retained.

The public probably misunderstands the position of the engineer when he urges that those of the profession engaged in public work should be made secure in their positions. It ought to be realized that the engineer is not only arguing for the benefit of those of his profession who are engaged in public service, but that he is also arguing for the only system that can produce the efficiency and economy in that service which every good citizen desires. What manufacturing firm could suc-

ceed in the struggle with its competitors if every time a general election was held all those holding responsible positions with the firm, in which they were able to do constructive work in developing its business, were likely to be displaced on a moment's notice by a set of men wholly inexperienced in the work?

The Logical Results of the Submarine Torpedo Boat

In our issue of May 13, following the sinking of the "Lusitania," we discussed the results that were likely to follow the rapid development of the submarine torpedo boat as a weapon of warfare. In this issue is printed a statement setting forth the present status of the submarine boat, which has been prepared for ENGINEERING NEWS by Naval Constructor Howard of the Washington Navy Yard, who is in direct charge of the work on the Government's new submarines.

The development of the submarine boat which has taken place within the past four or five years has been extremely rapid. The efficient and reliable operation of such a boat, like that of a motor boat or an automobile, depends upon the development and perfection of a great number of special details of its equipment. Everyone knows what a vastly different machine the automobile or motor boat of 1915 is from the automobile or motor boat of 1910. Some such development has taken place in the submarine.

Notwithstanding the development, there was, prior to the war, no recognition of the enormous potency of this new engine of destruction, save for some such isolated prophecy as that of Admiral Scott of the British Navy, who a little more than a year ago declared that the submarine boat had already made the dreadnought battleship obsolete. The naval experts of Great Britain promptly branded such an idea as absurd; and as Great Britain sets the fashion for the world in all naval matters, no other nation's naval authorities have as yet ventured to recognize the logical results of the submarine boat. Not only this, but as a result of the British military censorship since the war began, and an entirely natural disinclination on the part of the British authorities and press to recognize facts which militate against them, there has not been even a full recognition of the part that the submarine has played in the present war.

This is natural enough on the part of Great Britain; but the United States needs to know and to understand the facts. There is, for example, a demand by the Navy League that our Government borrow half a billion dollars at once to spend on national defense, chiefly, it is understood, on additions to the navy. There is little doubt that large expenditures for national defense will be made as soon as Congress meets. But the question is, On what shall the money be expended? It would be as absurd to decide on our military and naval plans without regard to the epoch-making revolution in methods of warfare which the European war has made as it would have been to buy muzzle-loading shotguns for our infantry at the close of our Civil War.

Notwithstanding all the limitations of the censorship, it is evident that the submarine torpedo boat has been by far the most important factor in connection with the naval operations of the war. And the chief accomplishment of the submarine fleet is not its sinking of the battleships and cruisers and other naval vessels, nor even the destruction it has wrought on merchant vessels. The great achievement of the submarines has been the shutting up of the British and German fleets in home harbors, merely because of the potential danger from submarine attack. This is not cowardice on the part of either combatant, as newspaper writers thoughtlessly claim. It is correct naval strategy. It should be understood that the German fleet is kept inside its own safe anchorages not alone because of the superiority in weight of gunfire of the British fleet, but also because the British submarines are as serious a danger to the German battleships and cruisers as the German submarines are to the British vessels.

The mere fact that the few submarines which each nation possesses constitute so great a peril to the main vessels of both navies as to keep them idle during the greatest war in history is the biggest feat which the submarine has accomplished.

Of course, it is understood that the lighter naval vessels—torpedo boats, destroyers and cruisers—have been more or less active, because their loss might be hazarded; and, as is well known, severe losses have occurred. Again and again it has been graphically proved how helpless are the larger fighting vessels in the presence of their concealed foe. One recalls the sinking of the three British cruisers in the North Sea and the resulting order that a vessel must seek its own safety if a companion vessel is torpedoed, leaving the drowning men to their fate. Other recent examples are the sinking of a British cruiser in the Adriatic at a time when she is said to have been protected by a convoy of half a dozen torpedo boats, and the sinking of a British destroyer and two British torpedo boats in the North Sea.

At the Dardanelles, such reports as have been published indicate that the achievements of the submarines on both sides have been the largest factor in the operations. The losses of the allied fleets have been so serious that, according to recent reports, the large vessels have been compelled to change their position and leave the allied troops unsupported.

There is, however, a prevalent idea, which finds support even in naval circles, that the destroyer type of vessel can make an effective defense against the submarine. It is easy to see why this idea should be given currency, for it would not be good tactics to officially admit that there is no real defense against submarine attack. Not only this, but the navy in all countries is a most conservative body. It will be a long and slow task to convince the rank and file of naval officers that the great battleships and cruisers in which they have taken such pride are as surely rendered obsolete by the submarine torpedo boat as were the grand old sailing frigates made obsolete when the battle between the "Merrimac" and the "Monitor" took place.

What is the foundation for the idea that the destroyer can put up an effective defense against submarine attack? Just this—that the destroyer, because of its superior speed and maneuvering qualities, *can elude the submarine* better than a larger vessel. It must be understood that the only safety for a vessel against the submarine's torpedo is to keep moving and changing its course. So long as the submarine boat remains submerged, a destroyer or any other vessel can do nothing to attack it. When the submarine

thrusts its periscope above the surface of the sea to get its bearings, if some lookout on the destroyer is lucky enough to catch sight of the little tube, a quick machine-gun volley may smash the periscope and blind the submarine. But a piece of iron pipe thrust a few feet above the surface of the waves is a very small object to search for over all the area within the radius of a mile or two from the ship. The chances are greatly in favor of the submarine, that it will obtain its bearings and submerge again before its periscope is discovered.

It should be added that the destroyer has one further chance. By a sharp lookout it may discover the wake of the torpedo discharged by the submarine before it reaches its mark, and it is said that a machine-gun volley directed just ahead of the torpedo will explode the charge and thus make the torpedo harmless. In smooth water and clear weather the course of a torpedo may be traced, and by quick action a machine gunfire may be brought to bear on it before it reaches its mark. But the feat of thus discovering and "winging" a torpedo during the minute or two that elapses from the time it is discharged till it reaches its mark is not a thing which can be counted on.

It is said, however, that a dozen or more German submarines have been captured or sunk by British vessels. No details have been made public as to the method by which the captures have been effected, but it may safely be assumed that the captures were made when the boat was on the surface, and some of them have probably been due to some derangement of the submarine's machinery preventing it from taking refuge by diving when danger threatened. It is understood, of course, that before the submarine submerges it is well-nigh defenseless. Its safety lies in the fact that, lying so low in the water and discharging no smoke, the submarine is pretty sure to discover an enemy before it is itself discovered. It can then submerge and seek to torpedo the other vessel; but if by any mischance it is unable to dive, it is liable to capture, since its speed is not enough for it to escape if pursued by a naval vessel.

The time required to prepare a submarine for submergence may vary all the way from 2 to 20 minutes. Upon this more than anything else, probably, depends the liability of the submarine to capture. A fast destroyer may travel a mile in two minutes. Should a submarine discover a destroyer approaching her, therefore, the submarine will have to dive very promptly or the approaching vessel will discover her and open fire.

Briefly stated, therefore, the submarine is a vessel which is defenseless when on the surface, but which when submerged cannot be fought by any means now known. The torpedoes which it discharges are fatal to any form of vessel ever designed, or which is likely to be designed. The latest type of American dreadnought battleship, the "Arizona," launched at the New York Navy Yard June 19, represents a total investment of about $16,000,000. In contrast the United States submarine torpedo boats now building cost $540,000 apiece, so that a fleet of 30 such boats could be built for the cost of one battleship.

It deserves emphasis that the submarine boat is a weapon for defense and not for offense. No nation can now go overseas and attack another nation successfully provided the other nation possesses a fleet of submarine boats and men competent to operate them. And it can have such a fleet at such a small cost compared with the enormous outlay required for modern cruisers and battleships that all the smaller nations of the world are sure rapidly to provide themselves with such protection.

In the present war, as we have seen, the submarine has been the controlling factor. Its development, however, is still going on. Already a German submarine has made the voyage through the North Sea, the Channel, the Bay of Biscay and the Mediterranean, a distance of over 3000 mi., requiring 40 days' time, and sunk three battleships after its arrival. The United States is soon to receive bids for two very large sea-going submarines which will have, it is said, an effective cruising radius of from 5000 to 10,000 mi.

It is yet to be proved, however, that such large boats, except for use in distant operations, have any advantage over the smaller vessels. It is said that some of the most effective work by German submarines has been done by vessels of only about 240 tons' displacement. Even smaller vessels may again come into use, such as were built in the early days of submarine development. In submarine attack numbers are the important thing. No matter how large a submarine is, it can do no more than fire a torpedo, and the amount expended on one submarine of the large sea-going type would build three of the smaller type. We may even see submarines built so small that they can be carried on board a large vessel and put overboard in case of discovery of an enemy.

There seems no escape from the conclusion that the submarine torpedo boat has rendered obsolete and practically worthless all existing types of naval vessels—battleships, cruisers and destroyers. They are unable to offer any effective defense to their underwater foe, whose missile directed against them is far more certain to effect complete destruction than the biggest broadside of the most heavily armed vessel afloat fired at point-blank range.

If there seems to be any reason to doubt this, let it be seriously asked what the big battleships and cruisers are good for. Their impotence successfully to attack shore fortifications, long an axiom of naval strategy, has been again demonstrated by the operations at the Dardanelles. The proper objective of the fleet is well known to be the fleet of the enemy. But why build a fleet of huge vessels to combat the enemy's vessels if they can be more effectively and certainly destroyed by submarine attack?

So much for the logic of the submarine as a weapon of national defense against naval vessels. Can the civilized world afford to permit its use against merchant vessels of the enemy and even against neutral vessels?

To give a fair answer to this question, we may best ignore the conditions of the moment, with all their inevitable accompaniments of international prejudice. Imagine that a few years hence some insignificant nation—let us say in Africa or in South America—provided, however, with a large fleet of submarine boats, should declare war against some powerful European nation—for example, Germany herself, possessing, let us suppose, a large merchant marine and carrying on a large foreign trade. It is evident that Germany would be powerless to attack her small antagonist, for it would be suicide to send either naval vessels or transports loaded with troops across the seas to be sunk by the enemy's submarines. It is easily imaginable, however, that the small nation might see an easy road to prosperity by emulating the example

of the famous Barbary pirates of the eighteenth century. We can imagine such a nation waging with submarines a warfare against every German merchant vessel, and declaring that every neutral vessel carrying goods either to or from Germany should be subject to capture and confiscation, which it could escape only by payment of a heavy ransom.

Suppose the great League of Peace, made up of the great nations of the world, were organized and in operation; the depredations of such an outlaw nation could not be stopped even by the combined forces of all the powers, by any operations at sea; only by attack on land.

This is only a brief suggestion as to why, in the interest of the world's welfare, no precedent should be established legalizing submarine attacks on merchant vessels. Should this be done, the submarine with its torpedo might easily become a veritable Frankenstein—potent to destroy the civilization which had produced it.

Letters to the Editor

River Terminals at Evansville, Ind.

Sir—In ENGINEERING NEWS, June 3, 1915, we note an article on Ohio and Mississippi River terminals, which states that terminals at Evansville are under consideration. Seven or eight years ago, in conjunction with the Evansville Sand & Gravel Co., we started the construction of a private river-and-rail terminal at Evansville. We now have a plant with derrick hoists, railway switches and warehouses, which we believe to be the best on the river, and which we keep busy for our own use. We transfer sand, gravel, steel, coal, lumber, groceries, furniture, etc., and have lifted a small gasoline cruiser out of the river to repair the propellers. Furthermore, we use a part of the wharf for the construction of river vessels. So we feel the terminals at Evansville are not merely "under consideration."

THE OHIO RIVER CONTRACT CO.,
Leslie P. Eichel, Secretary.

Evansville, Ind., June 5, 1915.

[Our inquiry and the article mentioned above related particularly to public or municipal terminal facilities on the Ohio and Mississippi rivers, but we are pleased to make note of the above-cited private facilities at Evansville.—EDITOR.]

The Project for a Reserve Corps of Engineers

Sir—A few years ago a committee headed by the late Alfred Noble and made up of prominent members of the American Society of Civil Engineers journeyed to Washington to ask for recognition and promotion for deserving civilian engineers employed upon the works in charge of the Corps of Engineers of the United States Army. As is well known, this committee failed to accomplish its purpose principally on account of strong opposition from the military engineers, but partly also because the members of the committee were insufficiently informed on their subject.

In the last few weeks another committee, also from the American Society of Civil Engineers, has been in Washington to discuss with the authorities the formation of a Reserve Corps of Engineers to supplement the Corps of Engineers of the regular army in case of war or other emergency.

A solution of the two problems studied by these committees would be found in the formation through proper legislation of a Reserve Corps of Engineers comprising the best material among the civilian engineers.

While the civilian engineers are not soldiers, they carry on the same work as the officers of the Corps of Engineers. They are educated technical men, and it would not be difficult to convert them into a military body by a moderate amount of training and instruction.

By organizing the civilians in a separate and distinct corps, much of the opposition raised by the military engineers would be avoided. The army engineer officers are not particularly opposed to the civilian engineers, but are unwilling to admit to their own corps any but graduates of West Point.

X. Y.

June 14, 1915.

Engineering Competitions in a Technical School

Sir—The editorial on engineering competitions in ENGINEERING NEWS, June 3, 1915, was very well taken, and the reasons why the use of competitions in the engineering profession is difficult are especially cogent.

In line with this it may be interesting to note that the Engineers' Society of Western Pennsylvania, in conjunction with several technical schools, some time ago realized the value of competitive work in the field of engineering and that more practical work should be injected into the technical courses of the schools. With these two points in view, the society formed a committee on engineering education, whose duty it is to obtain problems made by practical engineers out of their daily work.

These problems are then submitted to the students as part of their regular course by the respective schools and the solutions are turned in to the committee. Specially selected judges decide the contest.

This has now been done for three consecutive years. So far the plan has met with a great deal of favor by the school authorities and students, and many more schools have used the problems each year.

The branches in which competitive problems are being prepared are civil, mechanical, electrical, metallurgical and sanitary. It is rather early to judge the final outcome of such a movement, but from the results so far

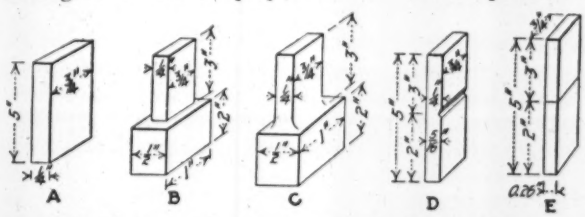
obtained it appears probable that a great deal of good will result from it, on account of getting real competition in engineering work and real and practical problems in the school courses.

A. STUCKI,
President, Engineers' Society of Western Pennsylvania.
Pittsburgh, Penn., June 7, 1915.

Progressive Fractures from Alternate Bending

Sir—The writer has been very much interested in the report of the broken axle on the Baltimore & Ohio locomotive tender and in your comments and that of your correspondents on Mar. 11 and Apr. 29.

Some time ago I had occasion to investigate the effects of nicks and changes of section in material, and the accompanying sketch shows the five sections that were tested. These pieces were clamped in a vise for a distance of 2 in., 3 in. being above the top of the vise and the uppermost portion being held by a lever which was pulled by hand from side to side. These pieces were subjected to alternate bendings 60 deg. on each side of the perpendicular, one alternation being one bend through 60 deg. and back to perpendicular. Twelve pieces of



TEST-PIECES FOR ALTERNATE BENDING

each size were tested, the material being ordinary steel exactly the same in each case.

The average results were as follows: Test-piece *A* gave 6.3 alternations. Test-piece *B* gave 3.1 alternations. Test-piece *C* gave 3.1 alternations; but test-piece *D*, with a 60-deg. V-notch $\frac{1}{16}$ in. deep, gave only 22½-deg. bend, bending away from the nick, and 60-deg. plus 40-deg. bend in bending first toward the nick. Test-piece *E*, with a very slight diamond scratch, averaged five alternations.

The immediate conclusions from these results are, of course, what have been long known among engineers—that changes of section and notches or nicks are exceedingly harmful; though why test-pieces *C* and *B* should fail so rapidly is very difficult to understand.

The writer believes, moreover, that if the test-piece *E* had been subjected to a large number of smaller alternations it would have broken down very quickly, as the effects of a diamond scratch are almost as noticeable in steel as in glass. In a high-grade specially hardened alloy steel they are of particular effect.

This progressive fracture is one which causes considerable trouble. From the mere fact that it goes on quite often for an exceedingly long time, and until a large percentage of the total area has become fractured, before complete separation takes place is evidence that the fiber stress must be reasonably low.

The writer has found in his experience that by increasing the size of the section and by paying special attention to the design and material used the tendency to produce progressive fractures can be very considerably reduced or largely eliminated.

JOHN YOUNGER,
Chief Engineer, Truck Department,
Pierce-Arrow Motor Car Co.
Buffalo, N. Y., May 13, 1915.

More About the Use of Vegetable Matter in Asphalt Pavements

Sir—In ENGINEERING NEWS, May 27, 1915, p. 1046, I note a short article on a "fiber" asphalt pavement laid in Charleston, W. Va., in connection with which my name has been mentioned.

I have nothing whatever to do with what is known as the "fiber" asphalt pavement. The pavement that I invented is purely and simply an improvement over the various classes of bituminous pavements. The finely powdered vegetable matter is practically the only addition to the aggregates used in my invention. This vegetable matter is added for the sole reason of absolutely sealing the voids in the mineral aggregate and acting as a second binder in order to hold the pavement firm on its foundation, doing away with cracking of the surface and allowing the pavement to have a greater amount of expansion and contraction without the surface cracking.

I now have two samples of this pavement, one of the sheet-asphalt type laid with an ordinary Florida sand, using about 30% bulk of sawdust in the mixture. This sample is now 16 months old.

The following extract of a letter from H. M. Sinnott, a representative of the Barber Asphalt Paving Co., who made a personal inspection of this pavement on May 27, is of interest:

> I wish to advise you that on May 27 I personally inspected the piece of pavement laid by you on the Cocoanut Grove Road near the City of Miami, Dade County, Fla.
>
> This is the piece of pavement that was laid by you as an experiment in February, 1914, using Bermudez asphalt, and, as you advised me, from 30 to 35% of sawdust in the mixture.
>
> This pavement is apparently in as perfect condition as it was the first time I inspected it, which was a few days after its completion. This pavement presents as good an appearance as any piece of pavement of the sheet-asphalt type that I have ever seen.

The other sample is of an asphaltic-concrete type using a crusher run of stone with the addition of about 35 to 40% by bulk of sawdust. This sample was laid at the Fourth Ave. and Jackson St. intersection in New Decatur, Ala., during July, 1914, and is in perfect condition.

The use of vegetable matter in these various mixtures also appears to make a noiseless pavement. We do not claim that the vegetable matter in the wearing surface is for the purpose of increasing the durability of the pavement, but that it is simply used as a void sealer and a binder. As it is in its own state a compressible matter, the use of sawdust will do away with the necessary grading of sands, such as are commonly used in a sheet-asphalt type of pavement, and will also do away with the grading of stone in an asphaltic-concrete type of pavement.

B. R. RENO,
General Superintendent,
Southern Asphalt & Construction Co.
Birmingham, Ala., June 4, 1915.

Electric Traction on the Norfolk & Western Railway

SYNOPSIS—This article, supplementing one in ENGINEERING NEWS, *June 17, describes the overhead contact lines by which 11,000-volt single-phase current is supplied to single-phase-three-phase locomotives. The power-generating and switching system is briefly taken up and some interesting minor points are noted—like the suppression of inductive disturbances in telephone and telegraph lines, the absorption of regenerated energy from braking trains, the arrangements for maintenance, etc.*

The use of 11,000-volt single-phase power for the electrified Elkhorn grade of the Norfolk & Western Ry. in West Virginia involves supplying current to the locomotives by an elevated contact wire (with the track serving as a return circuit). No supplementary feeders are employed, the power distribution from substations being entirely by the contact system (and track).

The primary object of the engineers in designing the overhead lines was to hold a No. 000 copper-alloy trolley wire at a uniform height of 24 ft. above the rails and in a location not varying horizontally more than 12 in. from the track center (corrected for superelevation effects). The wire over one track is isolated from that over another. Reliability in service and low cost of maintenance were especially sought.

The contact wire is supported by a single catenary cable, with an auxiliary messenger wire close above the trolley and parallel to it. The catenary is hung from guyed light steel cross-bridges, except in yard spans, where a cross-catenary cable is employed.

Insulators

A prominent feature of the design is the use of two or more insulators in series between all live parts and ground. This is possible with suspension-type disk insulators. A string of three disks is used throughout over the main line tracks. Each disk is good for 11,000 volts and has an ultimate mechanical strength of 12,000 lb. There has not been a single failure of an insulator string.

Catenary Bridges

The bridges supporting the catenary on the main tracks are made of tubular steel poles (sections of various lengths, sizes and weights being swedged together) and an H-section cross-beam. A change in size at the height of the cross-beams makes a shoulder on which sits a heavy steel casting for holding the cross-beam and for attaching the guy rods. The beams are partly supported also by side braces. The poles are grouted into rein-

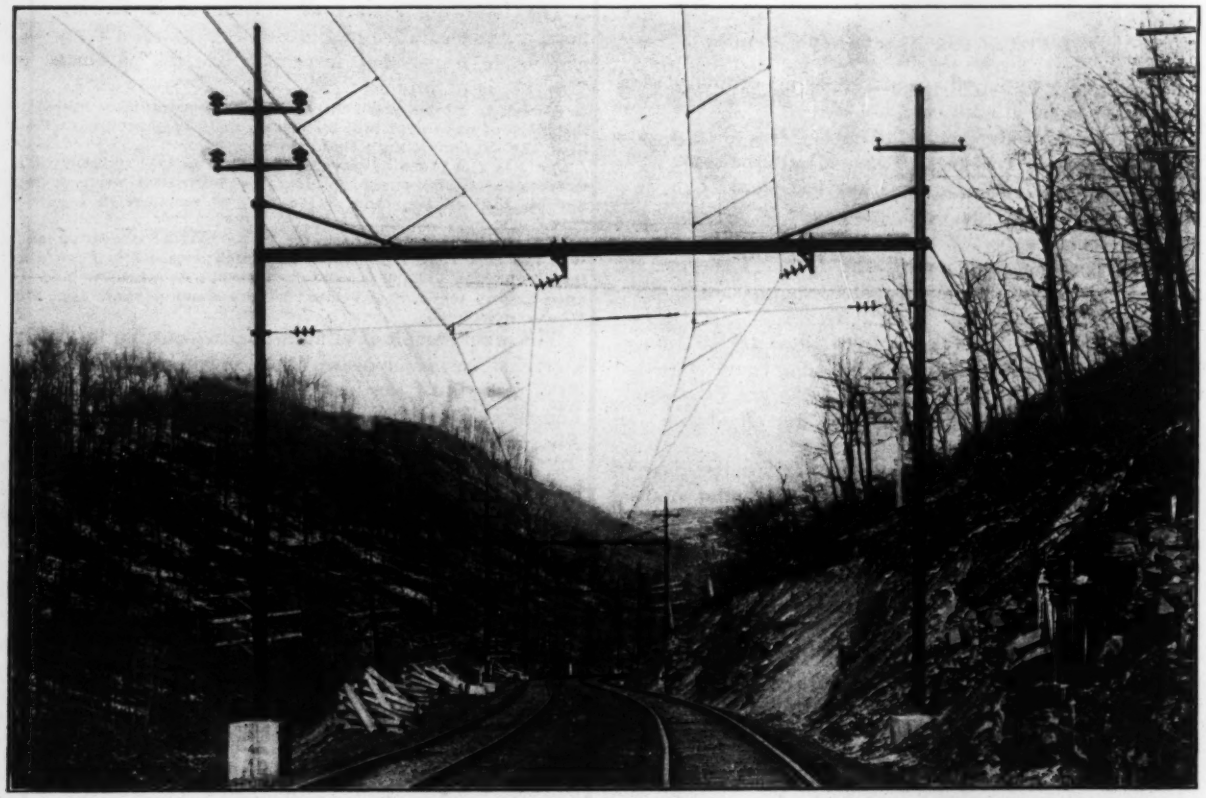


FIG. 1. TUBULAR-POLE CATENARY SUPPORT ON TYPICAL CURVE, NORFOLK & WESTERN RY.

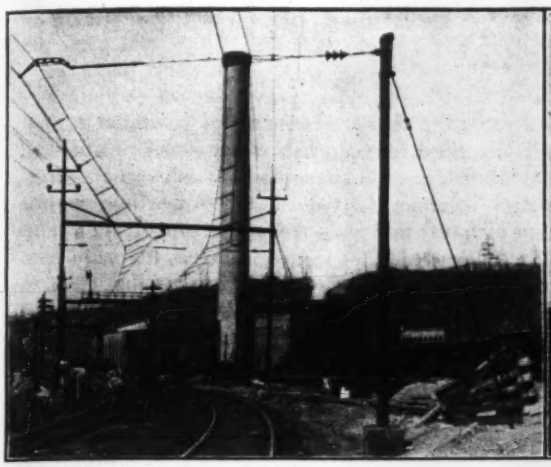


FIG. 2. PULL-OFF POLE ON TYPICAL SHARP CURVE
(Power house, and guyed and self-supporting bridges in the background)

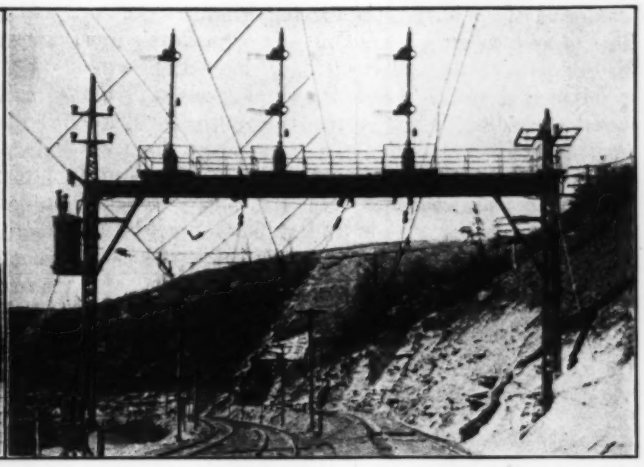


FIG. 3. SIGNAL-BRIDGE CATENARY SUPPORT
(Showing dead-ended messenger, contact-line breaks and booster transformer at the left)

forced-concrete foundations (1:2:5 mix) set in advance and cored with a collapsible form. A reinforcing collar of ½-in. plate protects the pole at and above the top of the foundations. Under the concrete is a copper plate with a bonding wire coming up to the pole.

BRIDGE GUYS

Each bridge stands alone on tangents, but is back-guyed on curves against the pull of the catenary, the guys carrying a considerable portion of the load. The guy anchors are concrete slabs containing two or more pieces of old rail, the size of each slab being such that its weight plus the dead-weight of earth above it is more than the maximum pull on the guys.

The guys are generally of round steel rod in three pieces. Where they pass through the earth they are protected by a boiler tube with grout filling. The upper sections of the rods are of uniform length, where the middle piece is cut as needed, with the final adjustment made by turnbuckles.

HEAVY BRIDGES

On curves where property for guy anchors was not available, unguyed light bridges, of structural posts and girders, support the catenaries. Where it was desired to anchor or dead-end the overhead system such bridges were used, but guyed along the direction of the track. Heavier bridges were used where both signals and catenaries had to be carried.

This type of supporting structure has proved very satisfactory where there is room on the right-of-way for guying. On long stretches of tangent track the cross-beams might interfere somewhat with the clear view of the signals; but here there is little tangent track, and no long stretches of it.

CATENARY ON TANGENTS

The construction over tangent tracks is very simple. A steel casting attached to the bridge girder supports a string of insulators, and to this, in turn, is attached a malleable-iron messenger clamp with arcing horns, so that if an insulator should break down the arc would be from the clamp casting and not the messenger wire.

The grip of the clamps is such that the cable will pull through at a certain tension; if a messenger breaks between anchors, it will slip through several supports adjacent to the break and distribute the abnormal strain over several intermediate bridges.

The main messenger is of ½-in. galvanized-steel stranded cable having a breaking value of over 30,000 lb. It is jointed by forged sockets designed to develop full cable strength. The nominal sag is 5 ft. in a 300-ft. span, but the actual sag depends on the particular span, which varies with the location. Every 30 ft. along the messenger are bent-strap clips which hold flat gal-

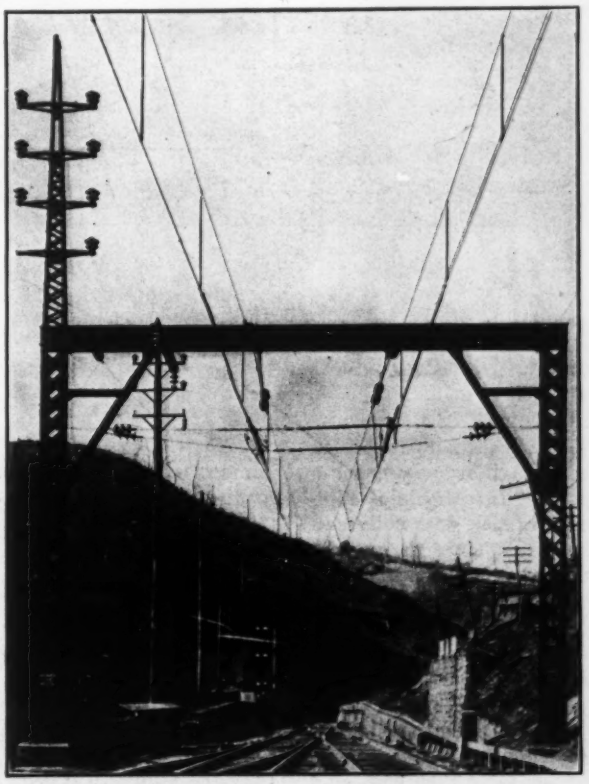


FIG. 4. SELF-SUPPORTING CATENARY BRIDGE; EAST PORTAL OF ELKHORN TUNNEL

vanized-steel strap hangers of varying lengths. On the bottom of each hanger is bolted a pair of malleable-iron trolley clips gripping the auxiliary messenger wire. The latter is a No. 0 round copper or steel wire, the material depending on the current-carrying capacity required. The grooved trolley wire is supported from the auxiliary wire by clips spaced 15 ft. apart and located between the main hangers. On the longer tangent stretches the running wire is held in place crosswise by steady strands insulated from ground and having 4-ft. impregnated wood-stick insulators between tracks.

Catenary on Curves

On curves the contact wire only approximates the track curvature, being permitted to be 12 in. off the center line of the track (or rather off the locus of the center of a locomotive-pantograph shoe because of outer-rail superelevation) in one direction at the bridges or supporting points and 6 in. off in the other direction at the center of the span.

The main hangers on curves are 15 ft. apart and grip both auxiliary messenger and contact wire at the same point. Intermediate clips are dispensed with. This construction does not result in "hard spots" in the overhead line, since the angularity of the hangers allows the contact wire to swing upward.

To avoid an uneconomically close spacing of structures on sharp curves (since the amount of trolley curvature obtainable with a fixed distance between supports is limited by the practical length of hangers and by the possible offset of insulators on the bridge), one or two pull-off poles are used between bridges. These are single tubular steel poles set in concrete, with single guys of the same type used on the catenary bridges. A wire strand from the pole top (insulated by a string of insulators) is fastened to both messenger and contact wire and serves to bend the plane of the catenary system, as shown in Fig. 2.

Yard Supports

Over yards the catenary construction is similar to that already described, except that cross-catenaries are used instead of bridges. Between two or more high structural-steel columns (guyed or self-supporting, as the location dictates) is a main messenger supporting a horizontal auxiliary cable. In some instances the main messenger is of 1½-in. cable having a breaking strength of about 240,000 lb. The hangers between top and auxiliary cables are ¾-in. rods and the connections are malleable castings. All cables are held to integral connection plates on the poles by heavy forged sockets and turnbuckles. In general all the cross-catenary materials are double galvanized.

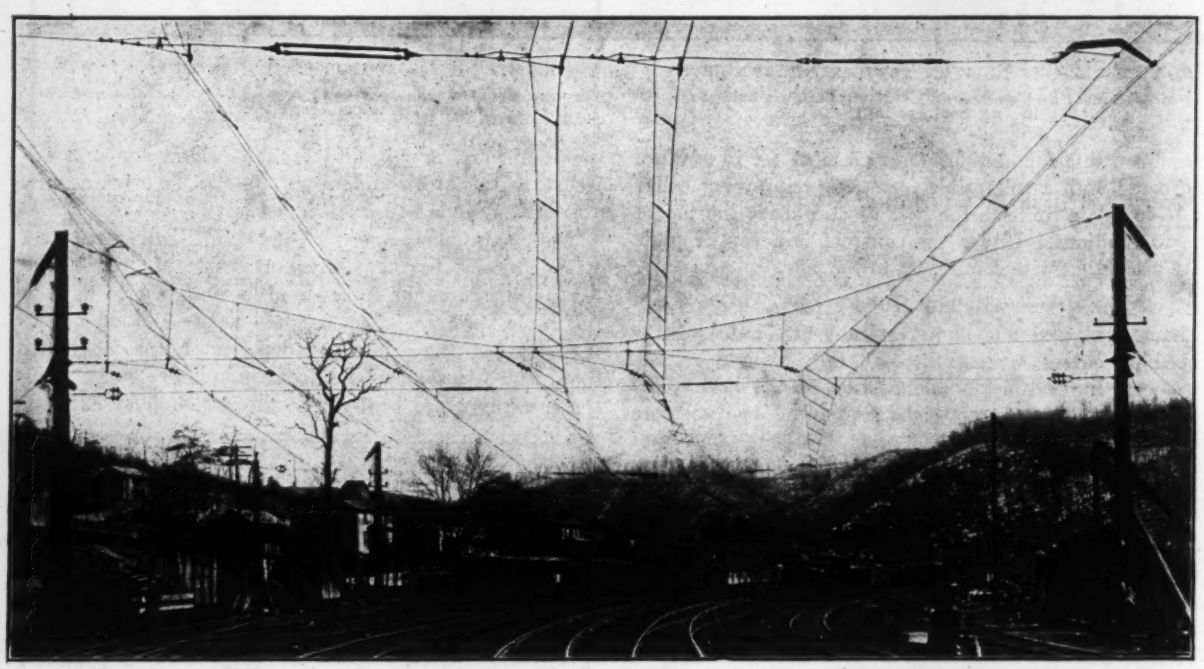


Fig. 5. Cross-Catenary Construction in Norfolk & Western Ry. Yards

Over sidings only two insulator disks in series are used and the auxiliary messenger wire is omitted. Chestnut poles and steel-bracket supports are used on branches and coal sidings.

Tunnel Construction

In the Elkhorn tunnel special construction was necessary. The walls are 14 ft. apart at the springing line and 13 ft. apart at the base; the springing line is 11 ft. 1 in. above the top of rails, and the top of the arch is 19 ft. 3 in. After experimental construction under high voltages with smoke and steam in a sample metal-lined tunnel the arrangement shown in Fig. 6 was worked out.

There is a supporting structure every 75 ft. Two cast-iron brackets are held to the brick lining of the tunnel by large bronze expansion bolts, and on each bracket is a 4400-volt transmission-line insulator. Between the two brackets is a 2-in. bent brass pipe carrying a third 4400-volt insulator on a bronze bracket. A

cross-pipe, bent to follow the arch of the tunnel, and going from this pair of brackets to a corresponding one on the other side, supports a bronze messenger wire. There are two bronze contact wires held by triangular hangers from the messenger. In spite of limited clearances the tunnel equipment has stood a test of three times the normal voltage and has been satisfactory in service.

Section Breaks

The running wire is sectionalized longitudinally where necessary by breaking the electrical continuity

Fig. 6. Catenary Support in Elkhorn Tunnel

of the messenger wire with two parallel strings of three disk insulators. Directly below this break in the messenger the auxiliary and running wires are attached by turnbuckles to the ends of a heavy impregnated wood-stick insulator. T-iron runners are connected to the ends of the contact wire and are supported by the wood-stick insulator approximately parallel to each other at the same elevation. Thus they overlap longitudinally, but have ample electrical clearance. The locomotive-pantograph shoe in passing underneath makes contact with the second runner before leaving the first, and there is no interruption of the current supplied to the locomotive.

Some of these breaks are provided to permit isolation of parts of the line for repairs, and the runners are normally connected by knife switches on top of the wood-stick insulators. The blades can be opened and closed from the ground by long impregnated-wood poles.

At certain locations the catenary system is dead-ended and anchored longitudinally by attachment to the cross-girders of structural bridges with a double string of disk insulators. These breaks limit the zones of mechanical trouble in case of wreck and broken messenger wire.

Temperature Changes

All calculations in the design of the overhead system were made for a normal temperature of 60 deg. F. With lower temperatures the tension in all wires is increased and the contact wire rises somewhat toward the center of the span. A 6-in. rise in a 300-ft. span will make a trolley-wire gradient of only $^1/_{12}$ per cent., whereas ½ per cent. is permissible. With rising temperature above 60 deg., tension is decreased and the contact wire sags uniformly, but well within permissible limits.

Track Bonds

The rail joints are bridged by 37-strand (0.0534-0.475-in.) copper bonds. Each bond as received has a terminal welded on one end, but the other end is left free so that it can be pushed under the fishplate. The loose terminal is then soldered on and both ends are expanded into holes in the rail web. At signal bridges insulated rail joints are placed in the track and impedance bonds bridge the gaps, preventing the flow of 60-cycle signal current while passing the 25-cycle propulsion current.

Telephone and Telegraph Protection

From experience with alternating-current traction it was judged necessary to protect all telephone and telegraph lines along the railway from interruption of service by physical contact with the high-tension wires and from induction effects set up in parallel stretches by the power currents. The company's telegraph and telephone pole line was moved to the south side of the right-of-way and all crossings over the high-tension wire were eliminated.

To help against induction substations were placed somewhat closer together than would be required merely from considerations of voltage regulation and losses, and the end substations were placed near the ends of the line. This results in feeding each important section of trolley from both ends, so that the voltage induced in the parallel telephone and telegraph lines is largely neutralized and localized.

In addition, to provide against emergency conditions with one substation out of service or in case of short circuits, etc., booster transformers have been installed in

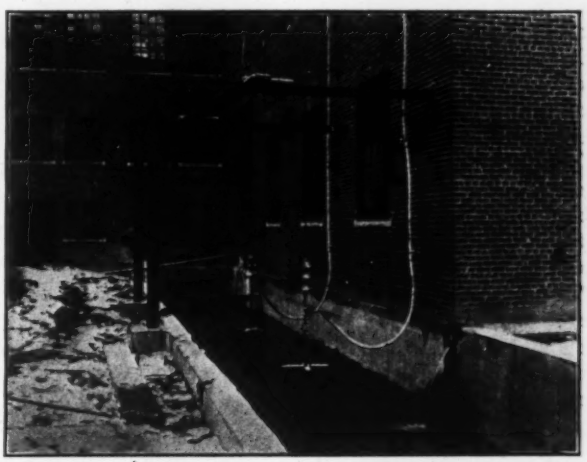


Fig. 7. Regenerative-Braking Rheostat, Bluestone Power House

the trolley and track circuits at 1-mi. intervals. These are series transformers, with their primary windings connected in series with the trolleys and their secondaries in series with the track at the middle point of the impedance bonds required at signals. These transformers were mounted on signal bridges (Fig. 3) and the track connections were carefully worked out so as not to interfere with signals. These transformers prevent the leakage of return current from the rails to the earth and thus keep the feeding and return circuits at a fixed distance from the telephone and telegraph wires. With

equal currents thus flowing in opposite directions in trolley and track the effect is still further to neutralize the induction in the telephone and telegraph lines. It is reported that since operation has been under way there has been no interference with the telephone and telegraph service.

Locomotive Inspection

Facilities for inspection and maintenance of the whole electric installation are concentrated at Bluestone, where the power station is located.

There is an inspection building and repair shop, 148x 68 ft. in plan, with two concrete main pits running the full length of the building—each accommodating one locomotive and equipped with power and lighting outlets.

The locomotives are not handled in the shop by their own power, but are drawn in and out by a cable and motor-driven winch in one end of the shop between the two main tracks.

Line Maintenance

The old locomotive-supply pumping station has become the headquarters for the line inspection and maintenance force. Here a full supply of materials is kept. A part of the building is fitted up as a bunk room for the repairmen who will be available day and night. On a nearby siding will be an emergency train, comprising a tower car, tool car and flat car to be drawn by a steam locomotive.

The ordinary repairs, however, are made by small gangs of three to five men using gasoline motor cars for carrying tools, materials and impregnated-wood extension ladders. Wherever possible the repairs are made from overhead bridges or from ladders, and while the line is alive, to prevent interruptions of service. Rigid rules are in force permitting the use of only one ladder at a time at one point, only one man on a ladder and no long lengths of wire. Some of the repairmen are regularly stationed at different points along the line.

A patrol telephone line runs the entire length of the electrified section, with instruments in locked boxes on signal bridges about a mile apart. This line leads to the power-station operator, through whom communication can be had with the train despatcher and other officials. The power director at the switch-board in the generating station is also in constant telephone communication with signal-tower operators, passenger-station agents, yard masters and all others responsible for the switching in substations and along the line.

Automatic Signals

The Elkhorn grade was formerly equipped with automatic storage-battery signals having semaphores on posts. Before electric operation started these signals were replaced by 60-cycle alternating-current apparatus adapted to the use of the track return for propulsion current and with the semaphores on certain catenary bridges.

Power Station

The power station follows lines of design familiar with steam boilers and steam turbines. The location, at Bluestone on the Bluestone River, was determined by the only available source of boiler-feed and condensing water in the district. The railway company had already built a dam and reservoir here for supplying steam locomotives.

The main structure, of brick, is 135x158 ft. in plan with a 52x33-ft. extension on the northeast corner for the 44,000-volt apparatus. The boiler room is 79 ft. 3 in. by 158 ft. 6 in., and the turbine room is 36 ft. by 158 ft. 6 in. The basement floors are at ground level, while the turbine room is 18 ft. and the boiler room 13½ ft. above.

On the ground floor of the transformer-house extension are the transformers, and on the second floor is the high-tension switching apparatus. The boilers, stokers, stoker engines and feed-water heaters are all on the main floor of the boiler room. Pumps, oil filters, air compressor, air-cleaning equipment and forced-draft fans are in the basement, with the pumps and filters in a separate room. The main generating units, exciters and signal current generators are on the main floor of the turbine room, with the condenser and fans for cooling the generators in the basement.

A section across the east end of the turbine room, 26 ft. wide, is used for switching equipment, offices, etc., and has intermediate floors and galleries. On the main floor is the low-tension switching room separated from the turbine room by heavy wire screens. The next floor above is the operating gallery. The top floor is used for offices.

There are three 10,000-kw. generating units, with space for a fourth. These are three-phase machines loaded on one phase for traction and carrying a small auxiliary load on all phases.

Cooling Pond

A spray cooling pond 90 ft. wide, 296 ft. long and 5 ft. deep is provided to take the water from all condensers when the supply of river water is low and muddy. When there is sufficient good river water the condensers discharge directly into the pond without spraying and the water flows down into the river reservoir. The basin is formed by a concrete retaining wall and a bottom of 6 in. of clay puddle, laid on a rolled subgrade and covered with 2 in. of asphalt concrete.

Regenerative-Braking Rheostats

The use of the locomotive-driving motors on down grades as generators returning power to the line for braking trains was outlined in the previous article. The excess power returned, when there are no trains on grades and the power-house load is very light, would pass back through the various transformers and reverse the generators so that they would run as motors. To prevent this, two loading rheostats, each consisting of a pair of electrodes in the power-house intake canal, are provided to absorb the excess energy. One electrode is a steel cone, dipping into the water and capable of being raised or lowered by a hand winch and cable; the other is an iron plate at the bottom of the canal and grounded to a copper plate bedded in the earth outside. The power-dissipating capacity of a rheostat is adjusted by varying the distance between cone and iron plate. The cones are connected through circuit breakers to the generator bus.

Action is made automatic by a group of relays, switches, current transformers, etc., so connected as to give the following action: When the returned power reaches 300 kv.-a., the relays and switches connect one pair of the electrodes on the bus. As soon as the returned power exceeds the capacity of one rheostat by 300 kv.-a., a sec-

and relay throws on the second pair of electrodes. The difference between the amount of returned power and the full capacity of the rheostats in service is furnished by the generator.

With two rheostats in service when the excess returned power drops to 2000 kv.-a., one set of the relays and switches disconnects one rheostat. The other remains on the 11,000-volt bus until the excess returned power drops to zero; then all of the rheostat load is carried by the generator and the second relay cuts the electrodes off the line.

Transmission and Distribution

Single-phase power is transmitted from the generating station to the substations along the line at 4400 volts and 25 cycles. There are two single-phase, high-tension lines the length of the section, comprising four No. 00 seven-strand hard-drawn copper cables. The wires are carried on the extensions of the catenary-bridge poles, except at the tunnels, where the transmission line goes over the summit on chestnut poles. A 3/8-in. steel ground wire is carried along the pole tops. The high-tension insulators are of a four-petticoat pin type giving a 165,000-volt dry flashover test and an ultimate mechanical strength of 4000 lb. at right angles to the pin.

All cross-arms are connected to a ground wire, which is connected to a copper plate at the base of every fourth pole. The high-tension lines are sectionalized at each substation by air-break switches on the roof.

Step-down transformers in the substations are connected to a bus, one side of which is grounded and connected to the running rails and the other side of which is connected to feeders which run to the contact system.

Substations

Brick substation buildings, housing the step-down transformers and switching equipment, are located at various points along the line (as shown in the map of the electrified section in the first article, June 17, p. 1192), except at West Vivian, where outdoor type of equipment is used because of the necessity of moving the substation when the electric-traction system is extended. One substation is located in the transformer house of the generating station, instead of feeding directly from the generator bus, on account of the greater short-circuit disturbances with direct feeders. The location and equipment of substations are summarized in the following table:

Substation	Miles from Power Station	Transformer Units, Kv.-A.	Total Capacity, Kv.-A.
Bluefield	E. 10	2-3000	6,000
Bluestone	0	2-2000	4,000
Maybeury	W. 5	2-5000	10,000
North Fork	W. 13	2-3000	6,000
Vivian	W. 18	1-2000	2,000
			28,000

The circuit-breakers in the substations cutting off current from the trolley wires are remote-controlled and are operated from adjacent signal towers or passenger stations. The substations therefore have no attendants.

The transformers are of a single-phase oil-insulated water-cooled type, water being obtained from a company pipe line. A portable transformer oil filter is provided for the substations, being transferred from one to another as required. In each substation is a 16-ton chain hoist for lifting cores out of the casing.

Equipment and Engineering

The heavy electrical equipment was designed and built by the Westinghouse Electric & Manufacturing Co., cooling pond by the Spray Engineering Co., power-house wire and cables, track bonds and oil filters by the General Electric Co., insulators and fittings by the Locke Insulator Manufacturing Co., steel cable and steel trolley wire by John Roebling's Sons Co., copper-alloy ("phono-electric") trolley wire by the Bridgeport Brass Co., copper trolley wire by the Standard Underground Cable Co., catenary-bridge poles by the National Tube Co., catenary structural steel by the Virginia Bridge & Iron Co., steel castings by the Fort Pitt Steel Castings Co. and the Standard Steel Works Co., malleable-iron catenary fittings by the Malleable Iron Fittings Co.

The entire installation was designed in all its details by Gibbs & Hill, of New York City, as the railroad's consulting engineers. The construction, except for some of the buildings and their equipment, was by a specially organized railway force under the direction of the engineers.

News of the Engineering World

Debris-Obstructing Bridge Seized by the Sheriff

During recent high water in the Kansas River the attorney for the Kaw Valley Drainage Board obtained instructions from the Governor of Missouri to the effect that the local sheriff should seize the bridge of the Kansas City Southern R.R. Co., which spans the river at Ohio Avenue, Kansas City, Mo. This bridge is 6½ ft. below the top of the levee, measured from its present lowest point of span, and is approximately 130 ft. short, the west abutment being entirely within the present bed of the channel as defined by the harbor lines.

This 130-ft. space is bridged by a timber trestle, which during high water collects much drift, as do also the three piers of the bridge. The drainage board's requirements are that bridges shall have not more than two piers in the channel, that the abutments shall be behind the harbor lines, and that the lowest point of span shall be as high as the adjacent levee grade.

The governor claimed authority for his act the fact that all navigable streams are under Federal jurisdiction, which is also vested in the drainage district in the event of there being any obstructions placed in the river, if these obstructions constitute a menace to life and property of the land owners in the district. The sheriff was ordered to turn this bridge over to the board of directors of the drainage district, who intended, in the event that the water rose to the lower girders, to remove the trestle at the west end of the bridge. This was done

on the afternoon of June 19, when the water was only 2 ft. below the structure.

There are only three bridges within the Kaw Valley Drainage District at the present time which fail to comply with requirements. These are the Kansas City Terminal, the Kansas City Southern Ry. and the Chicago Great Western R.R. bridges. These three companies are fighting the drainage board over the reconstruction of their bridges.

A Twin Highway Tunnel for Allegheny Co., Pennsylvania

Bids for a twin highway tunnel 4875 ft. long, with each finished tube 24 ft. wide and 18 ft. high, are to be received on July 12 by the county commissioners of Allegheny County, Pennsylvania. With the approaches, the total length of the improvement will be 5800 ft. The tunnel will be through shale. Its side walls will be of concrete. For the arch lining bids are asked on monolithic concrete, concrete blocks and brick. There will be a brick-paved roadway on a sand cushion and concrete foundation, two steel-bound concrete curbs and gutters, one brick sidewalk, and various drains, water pipe, and wire conduits in each tube. The improvement will extend from East Carson St. near Third St. in a southerly direction beneath Mt. Washington to Warrington Ave. near Boggs Ave., all within the City of Pittsburgh. It will provide direct highway connection with the business center for a section of the city which has had railway facilities for ten years. The county commissioners have authority to make a contract for running street-railway cars through the tunnel, but no steps to that end have yet been taken. It is purposed to ventilate the tunnel by blowing air into one end, after plans by Charles S. Churchill, assistant to the president of the Norfolk & Western R.R., Roanoke, Va. A. D. Neeld, 237 Fourth Ave., Pittsburgh, is Consulting Engineer for the County of Allegheny; Hyatt M. Cribbs is county controller.

Collapse of Arch Falsework, Detroit-Superior Bridge, Cleveland

On June 17 the steel arch forming the centering for the north inner rib of span 8 of the Detroit-Superior high-level bridge at Cleveland, Ohio, collapsed when 14 men were on it placing lagging for the concrete arch-rib. One man, the carpenter foreman, was killed and nine others were injured. The material damage was confined to the centering itself and to a minor scarring of the pier where the steelwork hit it in falling.

The Detroit-Superior bridge, described in ENGINEERING NEWS, June 18, 1914, p. 1348, comprises 12 concrete arches and one steel arch carrying a double-deck roadway over a total length of 2880 ft. The concrete arches are in four ribs, and their construction, now under way, is being carried out on two sets of three-hinged steel arches, one under each of two adjacent ribs. These steel arches rest on timber bents built close up to the piers, and are slid along the bents from one set of two arches to the opposite set. The thrust of the steel arches is taken by steel cables tying the end pins together.

FIG. 1. SPAN NO. 8, DETROIT-SUPERIOR BRIDGE AFTER COLLAPSE OF ARCH CENTERING

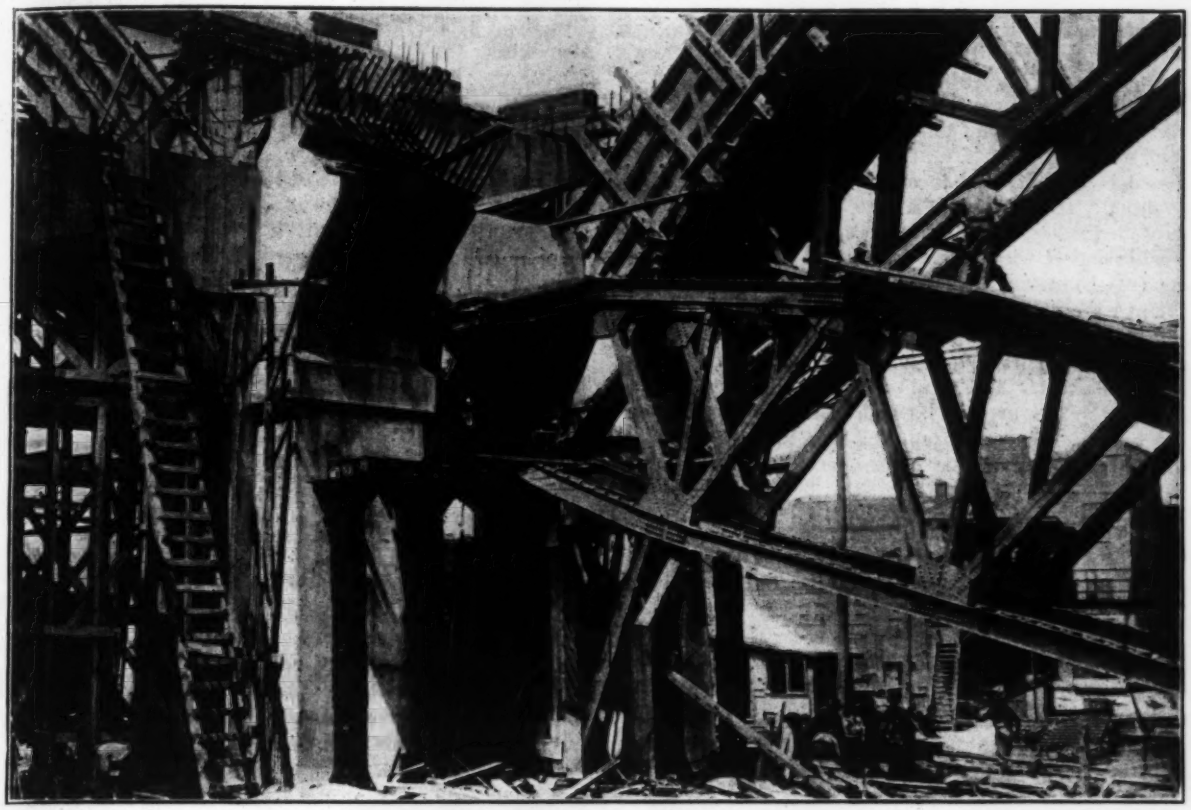


FIG. 2. NEAR VIEW OF COLLAPSED CENTERING

The concrete arch where the collapse occurred is 144 ft. 4½ in. long, and the span of the steel centering is 133 ft. c. to c. of end pins. The crown lagging was 60 ft. above the street. The collapse of the centers was caused by the breaking of two 1⅛-in. plow-steel cables tying the end pins together. The break took place when the centering was being moved along the supporting bents.

Fig. 1 shows the centering arches in place for the north outer rib and, in the foreground, the collapsed north inner rib. Fig. 2 shows the west leaf of the rib after failure. The haunch of this rib was forced against the concrete pier and in falling turned about the runway as a fulcrum, forcing the top chord against the transverse arch of the pier and chipping off a small piece of concrete. The 12x12-in. sticks on the supporting runway were all broken.

The bridge is being built for Cuyahoga County, Ohio, by the Hunkin-Conkey Construction Co. W. A. Stinchcomb is County Engineer and A. W. Zesiger is Bridge Engineer.

Another "Final" Decision on Flat-Slab Floor Patents

The United States District Court for the District of Minnesota on June 9, 1915, issued a decree providing for a perpetual injunction restraining C. A. P. Turner, of Minneapolis, Minn., from using his so-called "mushroom" flat-slab reinforced-concrete floor design, as described in his patents Nos. 985,119 and 1,003,384, which are ruled to be infringements of the Norcross patent No. 698,542. This injunction follows the decree of infringement handed down against Turner in favor of John L. Drum by the United States Circuit of Appeals, Eighth District, on Dec. 10, 1914 (ENGINEERING NEWS, Jan. 14, 1915, p. 91). A petition for a writ of certiorari was presented by Mr. Turner to the United States Supreme Court, but was denied on June 1, 1915.

The Norcross patent is now owned by the Flat Slab Products Co., McCormick Building, Chicago, Ill. This company has announced that it will license all who wish to design flat-slab buildings, charging a license fee of 1c. per sq.ft. of floor area, with a reduction for large areas used in one year.

Mr. Turner claims that the decision is still not final, inasmuch as the Norcross patent for a flat-slab floor is good only for steel reinforcement at the bottom of the slab. He admits that while he is enjoined from the use of direct and diagonal belts cob-piled over the column, the owners of the Norcross patent cannot build flat-slab floors without raising the steel to the top of the slab over supports, in which case, he contends, they infringe some of his patents which are still in litigation.

Opening Rapid-Transit Extensions in New York City

The first units of the new rapid-transit facilities in New York City have been opened for service. On June 22 the Fourth Ave. subway from Manhattan to Coney Island, via the Manhattan Bridge (see ENGINEERING NEWS, Oct. 1, 1914, p. 665), was put into regular service by the Brooklyn Rapid Transit Co. On the same day the Belmont or Steinway tunnel under the Harlem River was opened by the Interborough Rapid Transit

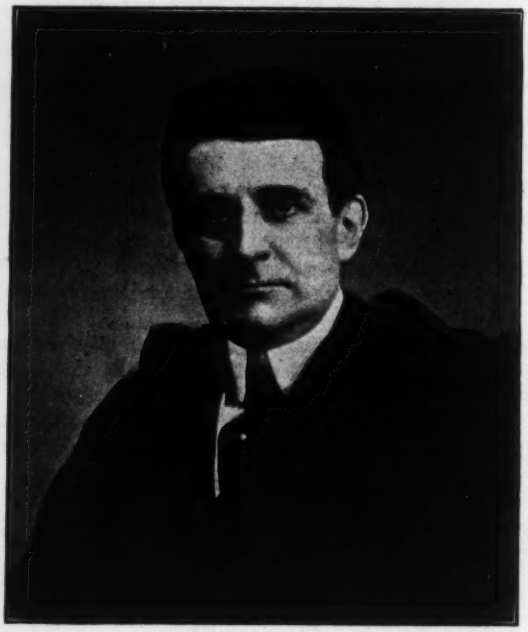
Co. for traffic between East 42nd St., Manhattan, and Long Island City, with transfers to the existing subway.

The Belmont tunnel is an old two-track project started in 1905. The tunnel was completed in 1907 (see ENGINEERING NEWS, Sept. 26, 1907, p. 348), but had never been used because of franchise litigation. It was purchased by the city and incorporated in the dual system. Eventually it will extend back to Times Square and forward to the east end of the Queensboro Bridge, whence it will connect with elevated lines to Astoria and Flushing (see ENGINEERING NEWS, Oct. 1, 1914, p. 666).

Until the Long Island connections are completed temporary service will be given with shuttle trains. At the Manhattan end passengers will be brought to the surface by an escalator. Twelve all-steel motor cars of the type used in the subway have been purchased for operation in the tunnel. Under the opening schedule there will be three trains of four cars each, operating on a headway of from four to five minutes.

A New $20,000,000 Cement Company

On June 9 a charter was issued under the laws of the State of Maine incorporating the Hagar Portland Cement Co., projected by Edward M. Hagar, Assoc. M. Am. Soc. C. E., who lately resigned the presidency of the Universal Portland Cement Co., Chicago, Ill., for the purpose of organizing a company to acquire and operate a chain of cement plants to cover the territory between the Atlantic seaboard and the Rocky Mountains. The capital stock is $20,000,000, all common.



EDWARD M. HAGAR

President Hagar announces the following officers of the new company: Morris Metcalf, Vice-President; B. H. Rader, Vice-President and Sales Manager; Gordon Wilson, Secretary and in charge of Cost Accounting; Leonard Wesson, Assistant to President in Operation and Construction; J. P. Beck, Assistant to President in Extension Work; C. W. Lyon, Engineer of Economies; J. L. Barbazette, Superintendent of Construction. Pending the election of a permanent Treasurer, the office will be filled by Gordon Wilson. The general offices of the company are located at 208 South La Salle St., Chicago.

Mr. Hagar is a graduate of the Massachusetts Institute of Technology of the class of 1893. He took a Master's Degree at Cornell University in '94. Shortly afterward he organized the firm of Edward M. Hagar & Co., in Chicago, which acted as agents for manufacturers of machinery. In 1899 he was appointed Manager of the Cement Department of the Illinois Steel Co. The steel company manufactured "Universal" portland cement until 1906, when the Universal Portland Cement Co. was formed with Mr. Hagar as President. He resigned the presidency of the Universal Portland Cement Co. in February of the present year.

Elimination of Garbage-Reduction Odors

A report on the elimination of odors from the Barren Island garbage-reduction works and two nearby plants, all taking garbage and dead animals from New York City, has been made by Irwin S. Osborn, Consulting Engineer of Toronto, Ont. (For copies, address Department of Street Cleaning, Municipal Building, New York City.) Complaints from residents near these plants led to the appointment of an investigating committee of city officials, citizens and representatives of the contractors. The committee engaged Mr. Osborn to study the problem in coöperation with Otto H. Klein, director of the Central Testing Laboratory. Mr. Osborn found that the equipment and operation of the plants were not such as to prevent odors. He recommends that measures be taken to prevent leakages of gases from the digesters and dryers; that condensers and scrubbers be improved, and in some cases enlarged; that more water and pumps be supplied for condensing and scrubbing; that the water used at the garbage-reduction works be metered; and that the city should thoroughly inspect the operation of the plants. The ENGINEERING NEWS is informed by John T. Fetherston, Commissioner of Street Cleaning, that the New York Disposal Corporation, which holds the contract for garbage disposal, is proceeding with the installation of new apparatus.

A Separate Sewerage System for Stockton, Calif., was authorized on June 15, when the people voted $350,000 for sanitary and $200,000 for storm sewers. D. J. O'Keefe is Commissioner of Public Works and George W. Pulich is City Clerk.

The Reconstruction of the Ohio River Bridge of the Cincinnati Southern Ry. at Cincinnati, Ohio, is under consideration, the general project being to erect a new and heavier superstructure on the present piers. The bridge is 3822 ft. long, including approaches. It has a 519-ft. channel span, two 300-ft. spans, and a 370-ft. drawspan, while the north approach has truss spans of 118 to 190 ft. It was built in 1877 by the Keystone Bridge Co., to the designs of J. H. Linville.

The Battleship "Arizona" was launched at the New York Navy Yard, Brooklyn, N. Y., on June 19. The arrangements were perfect. The 50,000 people admitted to the yard were in designated places. There were no cases of accident or sickness, though hospital provisions were complete. The vessel slid down the ways smoothly and took the water easily. The keel of the "Arizona" was laid Mar. 16, 1914. At the time of launching she was about 65 per cent. complete and weighed 13,000 tons. There was an added moving weight of 500 tons in slid-

ing ways, cradle and timbers. The speed of the ship on entering the water was about 15 mi. per hr. This is the fourth vessel built at the New York Navy Yard and the third in the United States Navy to bear the name "Arizona." It is 608 ft. long overall and 97 ft. in breadth, and will have a displacement of 31,400 tons. She will use oil fuel only and will have 34,000 hp. in Parsons-type turbines. Four propellers will give a speed of 21 knots. She will carry twelve 14-in. rifles and twenty-two 5-in. rapid-fire guns, two 3-in. field pieces and four aëroplane guns. The crew will number 927, besides 53 officers.

PERSONALS

Mr. Elwood N. Layfield, M. Am. Soc. C. E., of Chicago, Ill., has been appointed Assistant Secretary of the Western Society of Engineers.

Mr. Ben K. Curtis has resigned as City Engineer of Cañon City, Colo. Mr James Bunten, County Surveyor, has been elected to fill the vacancy.

Mr. Alger C. Gildersleeve, Assoc. Am. Soc. C. E., of New York City, has been appointed Secretary of the Chamber of Commerce of Bayonne, N. J.

Prof. Arthur N. Talbot, M. Am. Soc. C. E., of the University of Illinois, was given the degree of Doctor of Science by the University of Pennsylvania on June 16.

Mr. Thomas L. Fountain, Assoc. M. Am. Soc. C. E., of the Fountain-Shaw Engineering Co., of Dallas, Tex., has been appointed Engineer of Sewers of the City of Dallas.

Maj.-Gen. George Washington Goethals, M. Am. Soc. C. E., had his long list of doctors' degrees added to on June 15, when Princeton University conferred on him the honorary degree of Doctor of Laws.

Mr. Charles J. Hogue, Assoc. M. Am. Soc., C. E., formerly connected with the Cumberland & Pennsylvania R.R., has been elected President of Brownworth & Co., Constructing Structural Engineers, of Philadelphia, Penn.

Mr. W. C. Irwin, formerly of the Engineering Department, of St. Louis, Mo., has been appointed District Representative in St. Louis, of the Kalamazoo Railway Supply Co., of Kalamazoo, Mich. His office will be at 304 Frisco Bldg., St. Louis.

Mr. Daniel B. Sayer, Assoc. M. Am. Soc C. E., formerly of the firm of Major & Sayer, Civil and Contracting Engineers, of Wellsville, N. Y., has opened an office in Wellsville, where he will continue the practice of civil and contracting engineering.

Mr. Stewart M. Marshall, M. Am. Soc. M. E., formerly Chief Engineer of the Cambria Steel Co. at Johnstown, Penn., is now associated with the Southwark Foundry & Machine Co., of Philadelphia, as Manager of its turbine and centrifugal-pump departments.

Mr. Claude L. James, for several years City Engineer of Mattoon, Ill., has been appointed Superintendent of Water Works. He will continue to carry on a private practice as a consulting engineer. Mr. John A. Goetz will succeed Mr. James as City Engineer.

Mr. Charles S. Bilyeu, Assoc. M. Am. Soc. C. E., formerly New York Representative of Colby & Christie, Inspecting Engineers of Philadelphia, is now general manager of the inspection business of Hildreth & Co., Consulting and Inspecting Engineers, of 15 Broad St., New York City.

Mr. David F. Crawford, M. Am. Soc. M. E., Superintendent of Motive Power of the Pennsylvania Lines West of Pittsburgh, and, during the past year, President of the Master Car Builders' Association, received the degree of Doctor of Engineering from the State University of Kentucky last week.

Mr. D. L. Yarnell, Assoc. M. Am. Soc. C. E., who has been in charge of the local office of Drainage Investigations of the U. S. Department of Agriculture at Richmond, Va., has been transferred to the Office of Public Roads and Rural Engineering, 515 14th St., N. W., Washington, D. C. The Richmond office has been discontinued, but Mr. Yarnell will continue to conduct the work at the above address.

Mr. Julian M. Bamberger, formerly Vice-President of the Salt Lake & Ogden Ry., has been elected President and General Manager, to succeed his father, Mr. Simon Bamberger, who recently resigned. Mr. Bamberger's headquarters will be at Salt Lake City, Utah. Mr. J. B. Bean, formerly Secretary and Treasurer, has been elected Vive-President and Treasurer. Mr. E. J. Vail has been elected Secretary.

Mr. Charles McHercher, formerly Assistant Engineer of the Cuba R.R. Co., has accepted a position as Engineer with the Dibert, Bancroft & Ross Co., Ltd., of New Orleans and Camagüey, Cuba. Mr. McKercher will be in charge of the engineering of the company, which is building three mills on the island, and will also have charge of railroad location and construction for the development of the company's plantation in the Province of Camagüey, Cuba.

Mr. Edward F. Murphy, Division Engineer in Charge of Sewer Service of the Public Works Department of Boston, Mass., has been appointed Commissioner of Public Works, to fill the vacancy caused by the resignation of Mr. L. K. Rourke, M. Am. Soc. C. E. Mr. Murphy has been in the service of the city since 1887, rising through the grades of rodman, transitman, assistant engineer and district engineer, and finally division engineer. In his new position he will receive a yearly salary of $9000.

OBITUARY

James Everett Allen, Superintendent of the Street and Sewer Department of South Orange, N. J., died at his home in that city on June 16, in his 65th year.

Charles L. Haydock, Assistant Engineer at St. Louis, Mo., of the Missouri Pacific Ry., was drowned recently at Leavenworth Junction, on the Missouri River, while superintending the making of willow mattresses to prevent the river from undermining the tracks. He was 31 years of age.

Lieut.-Col. Charles E. Woodruff, Medical Corps, U. S. A., a well known sanitarian and authority on tropical diseases, died at his home in New Rochelle, N. Y., on June 13. He was the author of "The Effect of Tropical Light on White Men" and "Expansion of the Races." After his retirement, in 1913, on account of disability due to his service in tropical countries, Col. Woodruff served for a time as Chief Health Officer of New Rochelle.

Sir Nathaniel Barnaby, Honorary Vice-President of the Institution of Naval Architects, died on June 15 at London, England, at 86 years of age. He was long and widely known as a naval designer and author of several works on shipbuilding. He was Admiralty Overseer during the building of the royal ships "Viper" and "Wrangler" and was subsequently employed in the designing offices of the Admiralty at Somerset House. For a long period of years he was Head of the Designing and Building Departments of the Controllers of the British Navy. He designed the battleship "Inflexible." He was born at Chatham and educated at that place and at Sheerness and Portsmouth.

Brig.-Gen. Charles Julius Allen, U. S. A., retired, died at Asheville, N. C., on June 15, at 75 years of age. Gen. Allen was born at Buffalo, N. Y., and was a graduate of West Point. At the beginning of the Civil War he was assigned as First Lieutenant of Engineers, and was brevetted Captain in August, 1864. He won the rank of Major in March of the following year, and was Chief Engineer of the Army of Observation on the Rio Grande. After the war he was detailed on fortifications and harbor and river improvements, and during the Spanish-American War was stationed at Washington, D. C., in charge of defenses there. In 1904 he became Brigadier-General, and at that time retired, at his own request, after 40 years of service.

ENGINEERING SOCIETIES

COMING MEETINGS

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
June 17 and 18. Semi-annual meeting at Toledo. Secy., Frank E. Sanborn, Ohio State University, Columbus.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 22-25. Annual meeting at Iowa State College, Ames, Iowa. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 22-25. Summer meeting at Buffalo, N. Y. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 22-26. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Aug. 16-18 and 25-28. Annual meeting in Los Angeles, Calif., Aug. 16-18; in San Francisco, Aug. 25-28. Secy., J. C. Olsen, Cooper Union, New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 24-27. Annual convention in Cincinnati. Secy., Clarence R. George, Houston, Tex.

American Electric Railway Association—The headquarters of the American Electric Railway Association have been removed from 29 West 39th St., New York City, to 8 West 40th St. The secretary is E. W. Burritt.

New England Water Works Association—President Metcalf has appointed the following convention committee to arrange the details of the annual meeting: Alfred D. Flinn, chairman; W. W. Brush, F. F. Langley, H. B. Mocher, Fred S. Bates, and Charles W. Sherman. The convention will be held Sept. 7 to 9, in New York City, at the Waldorf-Astoria Hotel.

American Association of Landscape Architects—The Minneapolis Chapter has volunteered to submit to the City of Minneapolis sketch plans and specifications for a Minneapolis-Minnetonka driveway, which, it is stated, can be made one of the most beautiful in the world. Lake Minnetonka is about 12 mi. from Minneapolis and because of its broken character has a shore line of 100 mi.

Southwestern Water Works Association—The fourth annual convention was held at Galveston, Tex., June 14 to 16. About a dozen papers were read. A resolution granting associate members (supply men) the full privileges of the association was adopted. Action on the proposed constitution and by-laws submitted by L. H. Gray, of Lufkin, Tex., was postponed until 1916. Jesse Shaw, of Topeka, Kan., was elected president. The next convention will be held at Waco, Tex. E. L. Fulkerson, of Waco, Tex., is secretary and treasurer of the association.

Boston Society of Civil Engineers—The Joint Field Day at Pemberton, Mass., of the New England Water Works Association and the Boston Society of Civil Engineers was held on June 16, as scheduled. After luncheon at the Pemberton Inn, the water-works association held a business meeting, at which 81 active and 3 associate members were admitted. The unusually large number of applicants was partly due to the recent action of the association in remitting entrance fees to members of the American Water Works Association. After the luncheon a baseball game was played by teams from the two societies, with James W. Rollins and William S. Johnson as umpires. We have not yet been informed as to the score.

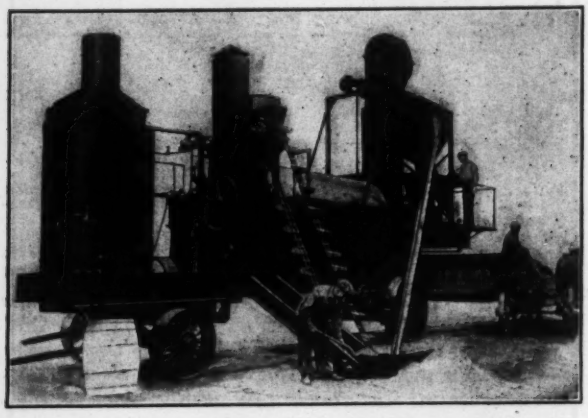
Appliances and Materials

Barber Portable Asphalt Plant

The new portable asphalt-mixing plant shown in the accompanying view has just been put out by the Iroquois Works of the Barber Asphalt Paving Co., Buffalo. It has a capacity of 800 sq.yd. of 2-in. sheet topping per 10-hr. day; its capacity for asphalt concrete or macadam is much larger. The plant is designed especially to meet the requirements of contractors and municipalities having new construction and maintenance work to perform in scattered territory or in an amount insufficient to make a stationary plant economical.

The mixing platform is elevated so that a wagon can be driven under it to load. The platform is arranged for one-man operation, the levers for controlling clutches, etc., being within easy reach. The mixer is a two-shaft, pugmill type, with removable side and end liners. It is provided with two full sets of blades, the binder blades being solid manganese-steel. The sand-measuring box and asphalt bucket are supported on scales. A special drying drum has been designed for this unit to insure a sufficient amount of heated sand and stone. There are removable steel wearing plates in the material chutes and chilled rims for all chain sprockets.

The paving plant having one of these machines would be operated as two units, the second unit being the asphalt kettle. The mixing unit can be supplied, however, without boiler and engine, so that the contractor or municipality already provided with portable boiler, engine and kettles can secure the mixing plant without duplicating that equipment.

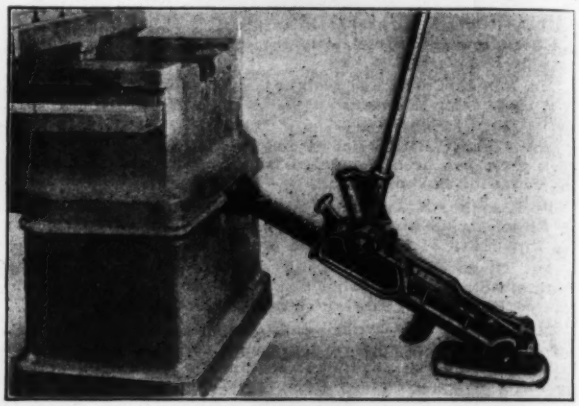


PORTABLE ASPHALT PLANT

* * *

Another Adjustable Jack

A jack with an adjustable base has recently been put out by Templeton, Kenly & Co., of Chicago, for use where pushing or lifting, or both, are required. As shown, the frame is a heavy ribbed malleable-iron casting. The base is broad and toothed on the under side. The frame bears on the base through two-faced circular shoulders and the pin carries no load. The rack bar and cap are forgings.

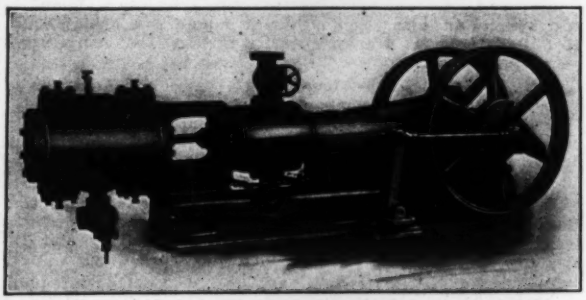


LIFTING AND PUSHING JACK

* * *

New Small Air Compressor

A new design of small air compressor, shown in the accompanying view, has been brought out by the Ingersoll-Rand Co., 11 Broadway, New York City, in response to a demand for small machines of greater efficiency. The new type resembles the company's older small machines, but has such improvements as the Rogler thin-spring air valves, balanced-piston steam valves (for either low or high pressures and superheat), automatic steam cutoff with centrifugal flywheel governor, splash lubrication, air unloader, inclosed construction with removable covers.



NEW SMALL AIR COMPRESSOR

* * *

Sewage-Ejector System

An ejector system for clearing sewage sumps or tanks in which any liquids have accumulated is being made by James Beggs & Co., 36 Warren St., New York City. The familiar scheme is employed of having a large chamber with inlet and outlet check valves on the bottom and inside a float controlling the admission of air above the liquid. In this design the float operates an electric switch which controls a solenoid-thrown air valve and connects the chamber alternately with the compressed air supply and the atmosphere.